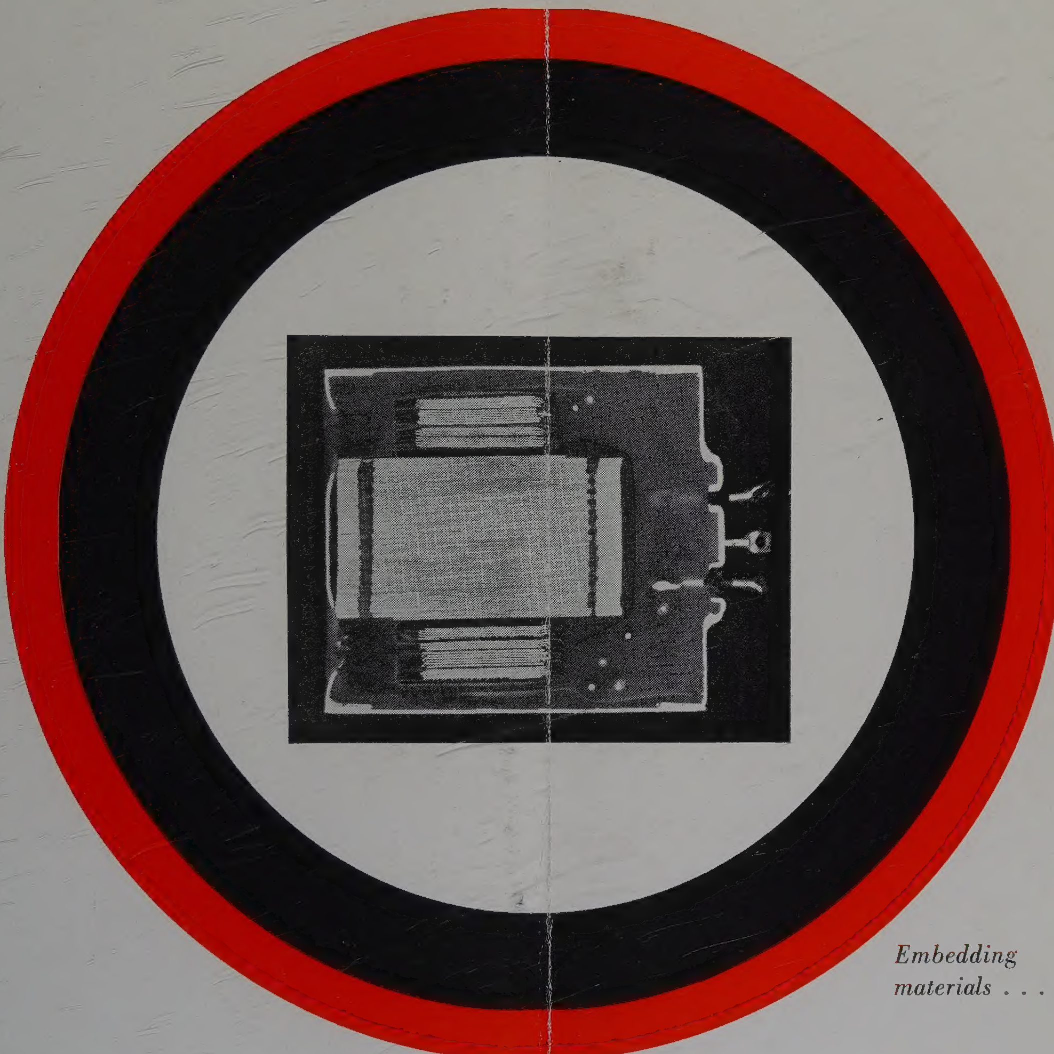
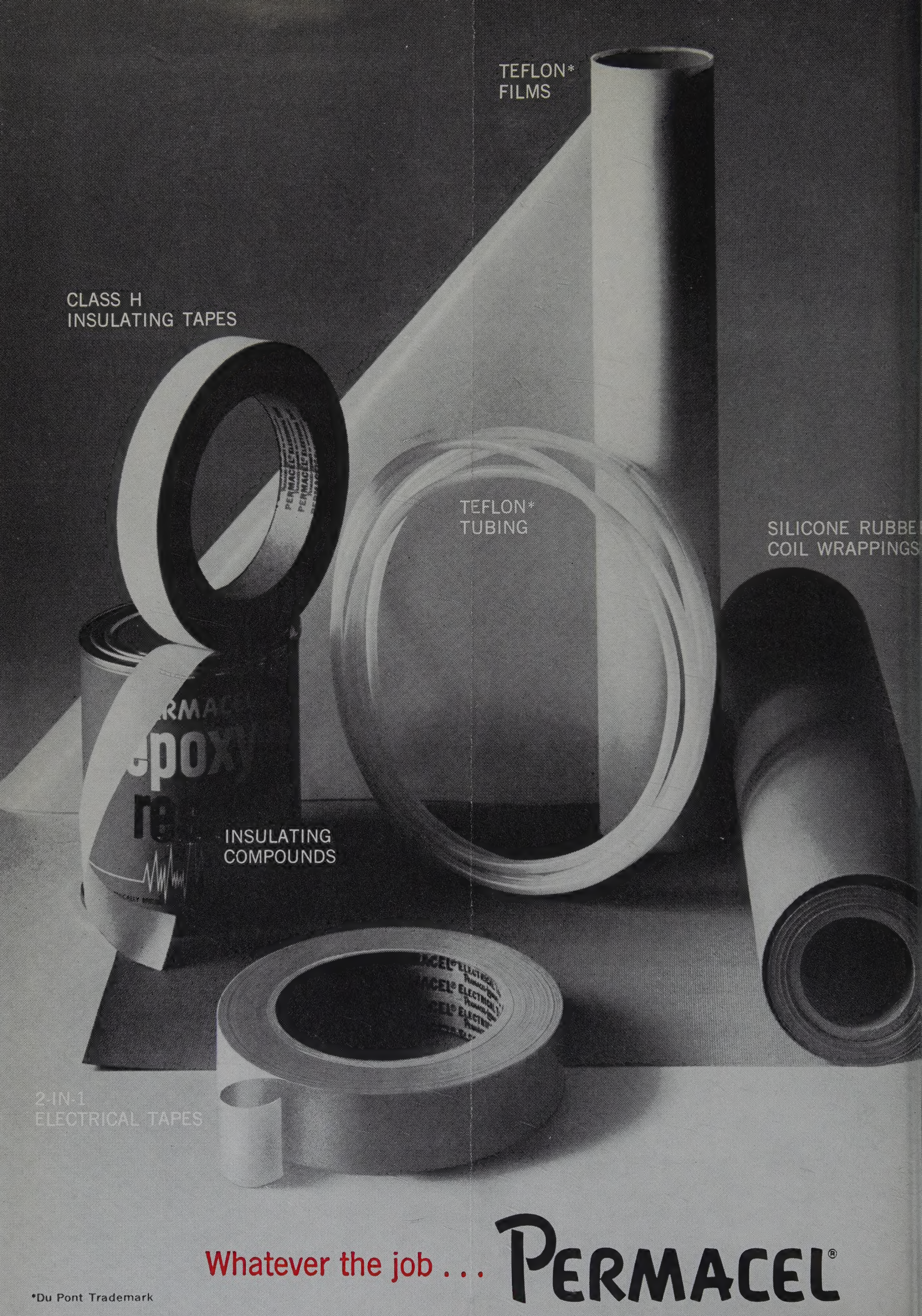
April 1961

Insulation



Embedding materials . . . . . page 33



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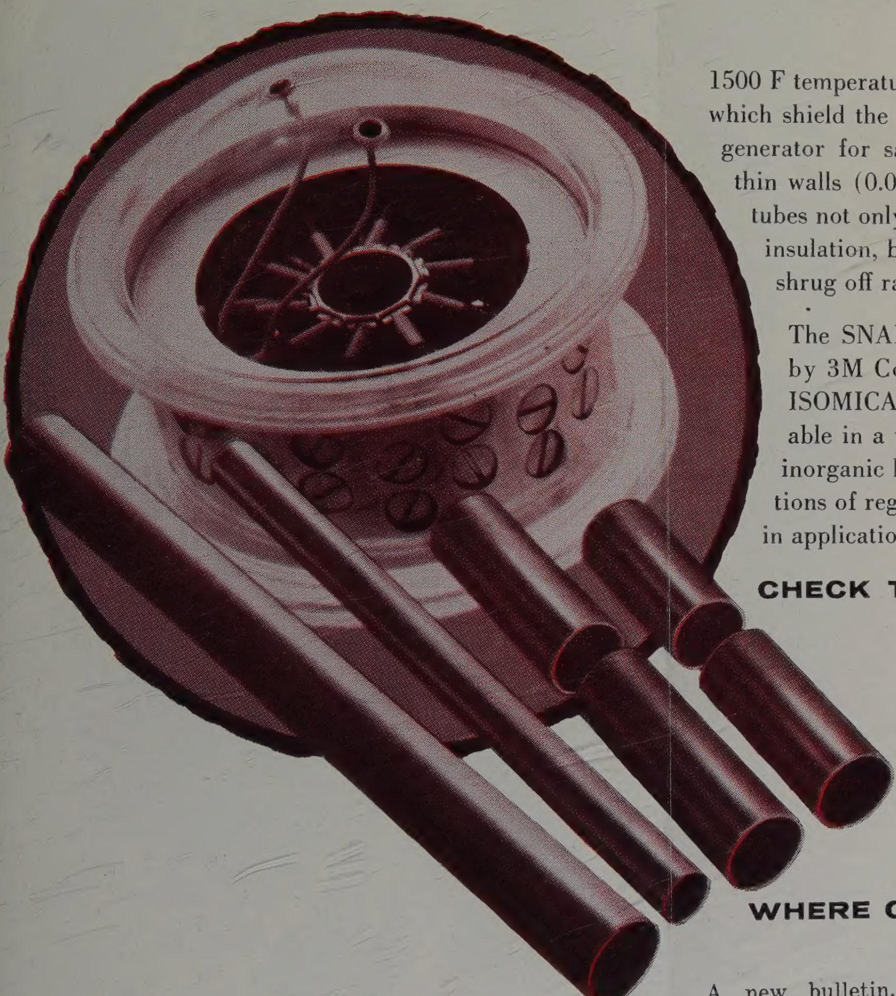

1500 F temperatures do not embrittle the ISOMICA tubes which shield the thermoelectric rods in this new compact generator for satellites. Feather-weight, with extremely thin walls (0.010″), these inorganic-bonded ISOMICA tubes not only provide excellent electrical and thermal insulation, but they do not contaminate the rods and shrug off radiation from the core.

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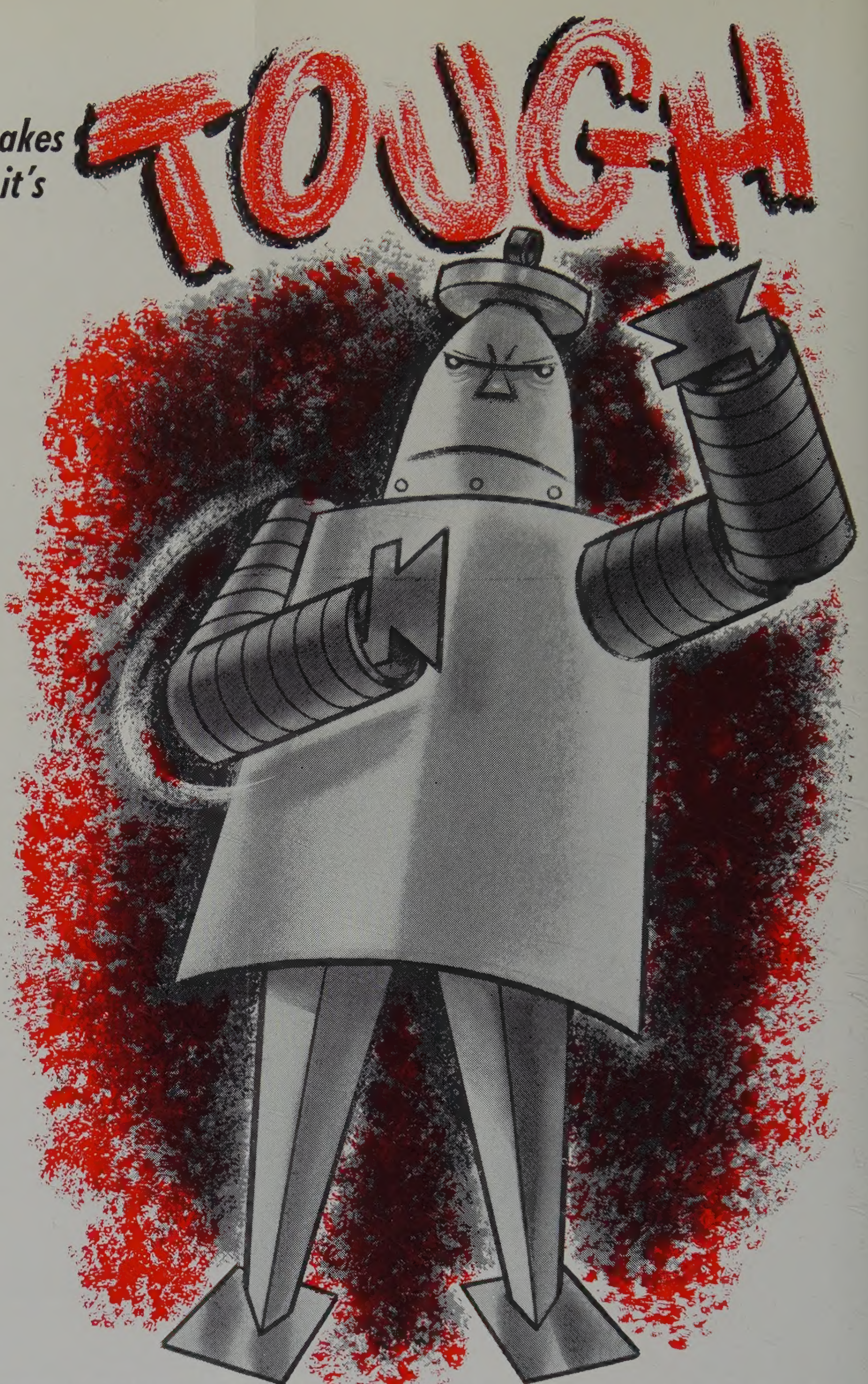

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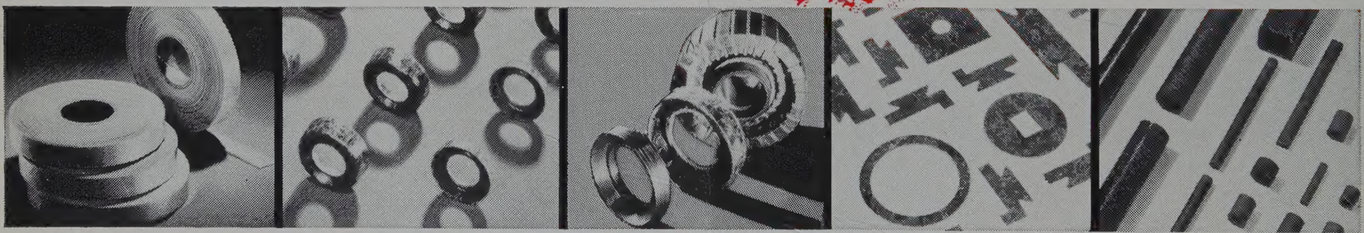

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Insulation

For the Electrical and Electronic Industries

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From the Editor

Opinions and Rambling Thoughts

Insulation Education

One of the crying needs in the electrical/electronic insulation field is the adequate education of competent engineers and scientists. Very few universities do any work at all in this area and those that do suffer greatly from the standpoint of quantity. Insulation training today is largely an on-the-job matter. In the past, this may have sufficed when insulation application was primarily a trial and error technology, but this no longer is true.

Since World War 2, or at least in the last decade, insulation has gained considerable stature and recognition as a separate specialty. Unfortunately, insulation education has not kept pace with the growing awareness of the importance of insulation.

There has been a great deal of talk about the need for more and better insulation education, but very little has been done. A number of suggestions have been made—some are being acted on today by dedicated individuals—but still, not enough is being accomplished and certainly, not fast enough. It would be well to review some of these possibilities in order to get an overall view of the situation and to try to tie together some loose ends.

First, we think two points should be made and must be considered. A "grass roots" approach is vital—the problem must be analyzed and then a tremendous amount of old fashioned legwork is required. Also, efforts must be coordinated in some way so that the effectiveness of whatever is done can be multiplied many times over.

A major stumbling block in accomplishing anything on both the undergraduate and graduate levels is the lack of organized instruction plans, adequate textbooks, teaching aids, etc. A start has to be made somewhere and there could be no better start than to sit down and actually decide what should be taught—how can insulation education be broken down into well-defined courses, what belongs where?

When it has been determined what types of courses are required, the next step is to actually outline the requirements for each course. Once this has been done, it will be possible to prepare textbooks. The writing, editing, and compilation of textbooks is not the monumental task it might seem—most of the basic information is available in the literature today but it is scattered and must be brought together into individual, comprehensive sources of information. There are well qualified men who can do this—men whose valuable time does not have to be begged and borrowed from other important projects—we're referring to the growing number of retired or semi-retired insulation experts who are veritable storehouses of insulation know-how.

And who would be better qualified to teach these insulation courses than these same textbook authors? These are the men who have been in industry and know both the practical and theoretical sides of insulation. Many of them, we are sure, would welcome such an opportunity.

How is all this to be accomplished . . . how do we interest schools in offering such courses . . . how do we interest students in taking such courses . . . how is such a project financed? The answer lies in a cooperative effort by industry, technical societies, trade associations, educators, and the government. Initially, industry would probably have to underwrite some of the expenses, but most important, industry would have to support such endeavors through the occasional loan of manpower and laboratories, and by aiding in the necessary public relations work. The government should be called on to support the program in every way except financially. All segments of the insulation field could work together with coordinated planning through all of the associations and societies which have an interest in electrical/electronic insulation.

The educational committees of each technical or trade group could be brought together into some sort of a semi-official organization to plan and follow through with unified action. Perhaps the electrical insulation conference could serve as the central "rallying point." The conference is already considering some excellent specific measures to help the insulation education cause.

Here are just some of the things that an insulation educational organization could do . . . most of them have been suggested by others and are not new: Industry teams could visit universities, armed with course outlines, textbooks, and teaching aids, to encourage the establishment of insulation courses. Letters could be written to faculty members and students stressing the importance of insulation courses. Students could be invited to attend technical insulation meetings with expenses underwritten by industry. During summer vacations students could be employed in insulation laboratories throughout industry. "In person" and printed promotional campaigns could be developed to sell management on the importance of supporting any and all projects. Insulation scholarships could be offered to deserving students. Awards can be made.

The preceding suggestions were just set down at random as they came to mind. Many other things could be done. Nearly all of them are practical. Nearly all of them are possible. It is time for the industry to organize itself in order to reach educational goals which eventually will help all of us. Insulation technology today represents a wedding of so many sciences that proper education is imperative.

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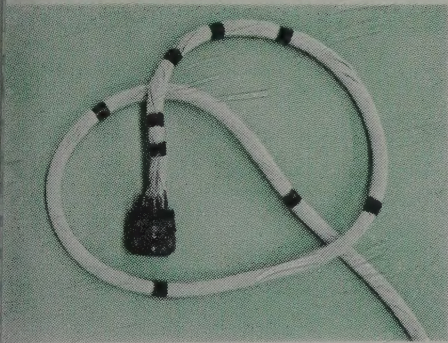

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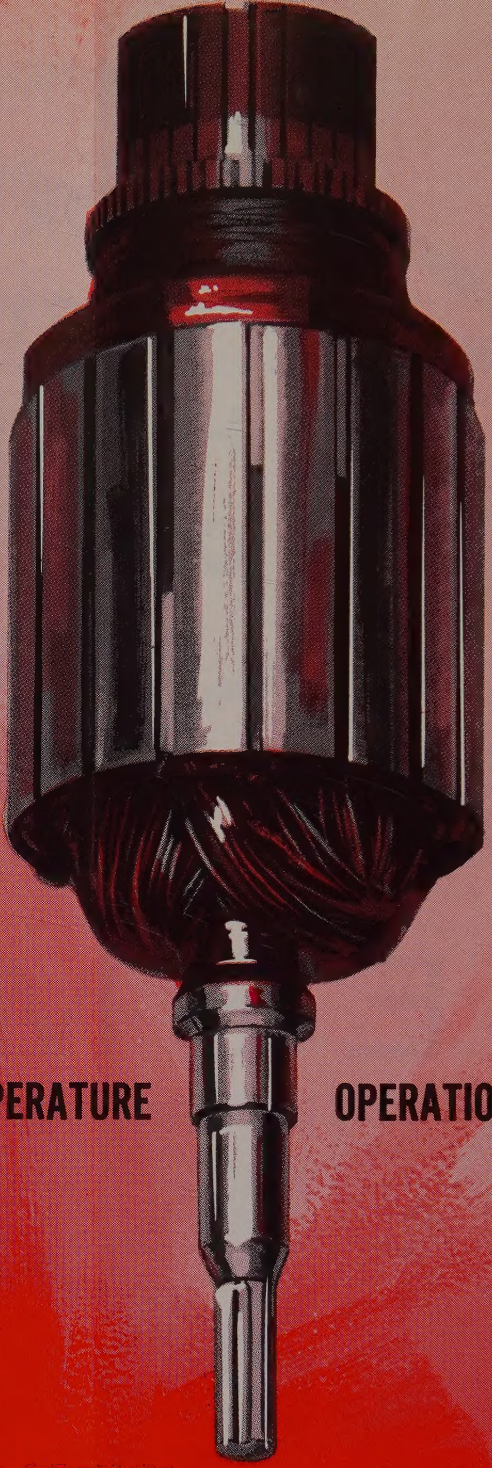

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J-M Integrates Insulation Operations

Johns-Manville Corp., in a move designed to streamline sales and coordinate electrical insulation material production, has transferred headquarters of its Dutch Brand division from Chicago to New York. The plant at Tilton, N .H., which produces asbestos paper insulation products, is now a Dutch Brand division facility. It formerly was operated by the Industrial Insulations division. The other Dutch Brand plant in South Chicago makes electrical tapes and other products. W. G. Hoffer, 1961 insulation application conference chairman, has been named manager of the division's electrical equipment sales department with merchandising responsibilities for electrical insulation products. W. H. Bartlett, manager for electrical products, will assist Hoffer on the sales of Tilton products. Other members of Hoffer's team of product managers are D. J. McLinden who is manager for industrial tapes and adhesives and A. G. Townsend who has been named manager for electrical tapes.

Experts Predict '61 Business Rise

Even though the recent past leaves much to be desired, there seems to be general agreement among industry leaders that 1961 should be a good year for many areas of business. In the electronics industry, L. Berkley Davis, president of the Electronic Industries Association, reports that 1960 saw a new all-time record of $9.75 billion in factory sales, a six percent increase over 1959. He optimistically predicts that there will be another six percent increase in 1961 for a total of $10.3 billion. It is interesting to note that many "experts" had forecast the demise of hundreds of small electronics firms in 1960—instead, these small companies generally increased their sales and grew stronger.

In the electrical equipment industry, R. S. Stevenson, president, Allis-Chalmers Mfg. Co., is hopeful that 1961 prices will be firmer and that 1961 orders will come close to 1960 levels. For his company as a whole, Stevenson is of the opinion that 1961 sales volume will be as good as 1960 and that profits will be better.

In the plastics field, the Society of the Plastics Industry, Inc. is predicting an increase of 5 to 10 percent for 1961 production of plastics materials. SPI contemplates that 1961 production will be between 6,465 and 6,773-million pounds compared with a 1960 estimate of 6,158-million. SPI estimates in pounds for 1960 are shown below:

	1960 Estim.	*1959 Actual*	*% Change*
Cellulosics	145,360,000	158,088,786	— 8
Phenolics	593,750,000	624,793,000	— 5
Polyesters	191,800,000	180,672,000	+ 8
Polyethylene	1,350,000,000	1,194,987,000	+12
Urea and Melamine	402,800,000	423,602,000	— 5
Vinyls	1,213,000,000	1,166,465,000	+ 4

SPI also estimates that in 1960 thermoplastic molding increased 15%, thermosetting molding declined nearly 10%, and extrusion increased about 20%.

Mass Produced Urethane Elastomer Parts Now Possible By Extrusion, Injection and Transfer Molding

The time necessary for the production of cured urethane elastomer parts reportedly can be cut from hours to seconds with a new "Texin" resin in granular form being introduced by Mobay Chemical Co., Pittsburgh. Previously, it was necessary to use a lengthy and costly liquid casting method for producing urethane elastomer items—the material permits the use of existing molds and equipment and cured properties are said to be identical to those of cast urethane elastomers. In addition to injection and transfer molding, the resin can be extruded for such applications as cable jacketing and tubing.

Properties claimed for Texin parts include exceptional toughness, resistance to abrasion, elongation of 2½ to 8 times the original length, and resistance to oils and solvents. On a comparative basis, hardness values can range from that of a soft, highly-plasticized vinyl plastic to that of a hard molded nylon. It is expected that liquid casting of urethane elastomers will continue to be used for large-size items that would require heavy mold design costs.

Joint Polyethylene and Polypropylene Production by Shell and Union Carbide

Union Carbide Plastics Co. and Shell Chemical Co. have contracted for the custom production of polypropylene and high-pressure polyethylene. Union Carbide will produce polyethylene for Shell while Shell will manufacture polypropylene for Union Carbide. The agreement permits Union Carbide to develop the polypropylene market without the necessity at this time for substantial plant investment and it enables Shell to participate immediately in the polyethylene field.

Price Reductions

DuPont has cut the price of its "Delrin" acetal resin from 80 to 65 cents a pound in a move designed to further widen the markets for the resin. The resin was originally introduced at 95 cents a pound. The material is being used now in an electrical circuit breaker and in many non-electrical applications where it is replacing metal.

The Silicone Products Department of General Electric has reduced prices for the third time within the last year and a half on silicone fluids. The reduction averages 5 cents per pound and includes the SF-96 series of fluids which are used as dielectric liquids.

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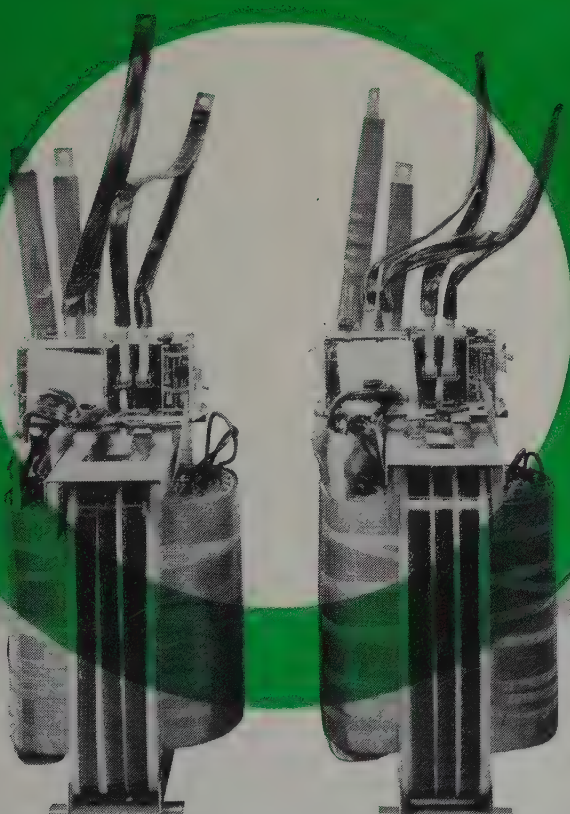

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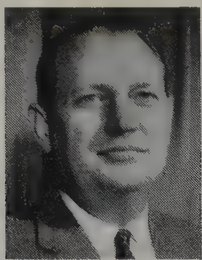
Insulation Forum

This regular monthly feature is built around a timely question concerning the electrical insulation field. Your suggestions for future questions and participation are invited. This month's question is:

What are your thoughts on the future of foamed plastics for electrical/electronic applications?



Michael M. Suba

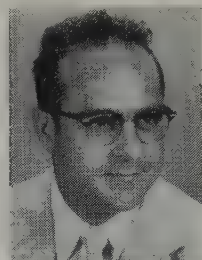
Sales Manager, Extrusion Products, Union Carbide Plastics Co., Div. of Union Carbide Corp., New York, N.Y.

"The increasing interest in foamed or cellular plastic extrusions in the wire and cable field can be traced to the reduction of material costs available with cellular extrusions. In addition to this principal motivating factor, the development of polymers that are tougher and of improved blowing agents now makes possible cellular plastics that will "out-perform" solid materials in many communications applications.

"Because of its exceptionally low-loss electrical properties, cellular polyethylene has already established itself as insulation for high-frequency applications such as video pairs, community coaxial cable, antenna lead-in, and automotive lead-in cable.

"There is strong evidence that within three years, cellular polyethylene will replace solid polymers as insulation for telephone cable singles. In addition to the economies to be gained, the cellular polyethylene will make possible singles insulation with comparable or better dielectric properties at reduced wall thickness, hence a smaller, lighter cable.

"At present, fibrous materials such as cotton and jute are being used as bedding for the insulated members or to fill out many cables. These materials pick up moisture, are poor dielectrics, and tend to degrade the overall performance of the telephone cable. Fillers of cellular polyethylene show promise of ultimately replacing fibrous materials although it will take considerable time to overcome the great cost advantage of materials such as jute."



Harvey L. Loucks

Materials & Processes Engineer, Engineering Laboratories, Bell Aerosystems Co., Buffalo, N.Y.

"The future of foamed plastics for electrical/electronic applications looks very bright. There is a large family of foamed plastics presently available to the electronic engineer and many new types are constantly being introduced. The various densities; chemical, physical, and electrical properties; and temperature limitations of the foams present a wide range of 'natural' materials for electronic applications.

"Lightweight foamed plastics may be bonded or foamed-in-place to provide thermal insulation from heat and cold. Foams may be utilized as vibration isolators in the 'as is' condition or by fabricating sandwich-type mechanical elements. The electrical properties of plastic foams render them highly desirable for potting and microwave applications. Some foams are even suitable in nuclear irradiation environments."

L. V. Gallacher

Technical Staff, Development Services Dept., Arma Div., American Bosch Arma Corp., Garden City, N.Y.

"The use of foamed plastics will expand, with more emphasis on the low thermal conductivities and low dielectric constants offered by foams.

"Thermal conductivity coefficients as low as .11 BTU/hr/ft^2/°F/in can be obtained with rigid urethane foam blown with halocarbons. These foams are ideal for thermal insulation where controlled - temperature environments or thermal inertia are desired.

"In many capacitance-sensitive circuits the preferred encapsulant is plastic foam. Foams have inherently low dielectric constants ranging approximately from 1.05 to 1.50 in normal density ranges.

"For general encapsulation problems, particularly in airborne equipment, foams have the obvious advantage over other materials of low density (to 2 lbs. per cubic foot and lower). However, as circuitry becomes more compact and power densities rise, the low thermal conductivity of foam encapsulants creates overheating problems and the density of the encapsulant becomes less important. The net result will be that solid encapsulants like epoxies will be more attractive for this type of work."

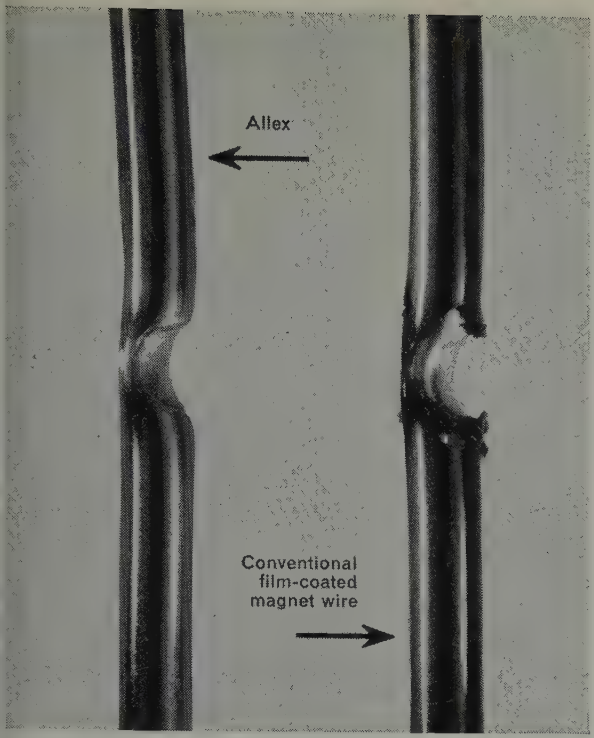
D. Petrino and J. Borsellino

Chemical Div., Thiokol Chemical Corp., Trenton, N.J.

"Although the market for foamed plastics in electrical/electronic applications appears to be quite small, we do feel that foamed plastics will play an increasingly important role in this field.

"The advantages of foamed plastics are widely known today for insulation, and to some extent regarding load-bearing properties. What has not been widely publicized is the application of foamed plastics in the potting and encapsulation field. The use of these materials for potting and encapsulation provides light weight, excellent electrical properties, resistance to fungus, low water absorption, low water vapor transmission, and protection of the electrical unit.

"A specific application which Thio-



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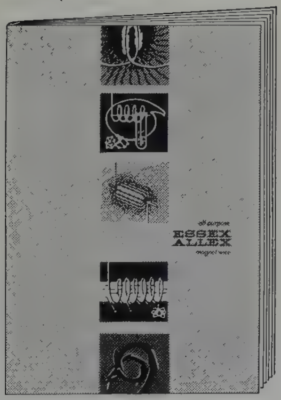

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kol participated in with the American Bosch Arma Corporation was the development of a good electrical insulator which maintained its properties after being subjected to humidity and temperature cycling. The foamed plastic (Rigithane 112) had to withstand vibration and shock at high energy levels, and had to cure at room temperature to prevent damage to the components that were being encapsulated.

"Specifically, the encapsulated part consisted of a back-to-back printed circuit. The package is composed of two 6″ x 9″ printed circuit cards which are mounted back-to-back on an epoxy/glass spacer. A space of approximately 3/16″ between the cards is filled with a Thiokol semi-rigid urethane foam which is poured-in-place. Although the foam adds only 40 grams of weight to the package, it contributes considerably to the vibration characteristics.

"Another successful research project at Arma resulted in the replacement of cork insulation by urethane foam in accelerometer covers. The cover consists of two metal cups, one inside the other, with approximately ⅛″ space between. Foaming-in-place is accomplished by weighing the desired amounts of the two-component urethane system into the outer cup, mixing, positioning the inner cup, and clamping. As the foam expands, it completely fills the cavity."

F. A. Goba

Manager, Electrical Section, Research and Development Laboratories, Canadian Westinghouse Co. Ltd., Hamilton, Ontario, Canada.

"Foamed resins are currently used in a number of important areas.

"Packaging in foam resins provides support and increases the shock resistance of electronic assemblies and instruments, both in actual service and during transportation.

"Both sound absorption and thermal insulation are readily achieved in electrical equipment such as appliances by the use of foamed resins. In some cases, the thermal conductivity and fire resistance of the foam has to be increased by special compounding. Development work in this field is relatively active.

"Foamed resins are used as RF absorbers in defense and commercial microwave equipment. Foaming-in-place permits filling difficult-to-get-at cavities and conforming with irregular shapes.

"Foamed resins can also serve as displacement materials in electrical equipment to reduce equipment weight and save other materials such as insulating liquids and transducer fluids.

"HV insulation with a low dielectric constant has been developed using foamed resins.

"It is the opinion of our Research and Development group that new areas of foamed resin application in the electrical industry will be added in the near future."

W. M. Bower

Materials Engineer, The Bendix Corp., Kansas City, Mo.

"Foams, both polyurethane and silicone, have proven themselves very useful for potted assemblies requiring vibration resistance, shock resistance, and temperature shock resistance (—65-160°F) where light weight is a factor."

J. G. Stranch

Senior Chemist in Charge of Plastics Laboratory, Tenite Development Dept., Tennessee Eastman Co., Kingsport, Tenn.

"In my opinion, one of the largest future uses for foamed plastics will be the use of cellular polypropylene as the primary insulation in multiconductor cable for communications. The reduced dielectric constant possible with cellular formulas will make it possible to use a thinner coating than is currently used with solid polyolefins while retaining a desirably low capacitance between wires which run side-by-side for long distances. The allowable reduction in coating thickness will both increase the economy of coating and make it possible to run more wires through conduits and cables.

"The polypropylene used in this application will not be an ordinary grade of material. It must be a premium-quality polymer with outstanding resistance to oxidation and physical properties such as good toughness, hardness, and abrasion resistance which extend to very low temperatures. It must have a low ash content and a low content of polar material in general, in order to keep the dissipation factor low. It must be supplied in heat-stable colors using colorants which do not impair the electrical properties excessively. It must be capable of use in wire-coating operations at speeds in excess of 2,000 feet per minute, and of course, it must be capable of being foamed."

P. Hersch

Physicist, Nopco Chemical Co., Newark, N.J.

"Polyurethane foams are important in the electric and electronic field because they have these properties: 1) Low dielectric constant (about that of air) for densities up to 10 lb/ft^3. 2) Low loss tangents (little transmission attenuation). 3) High resistivity. 4) High dielectric breakdown strength.

"This makes polyurethane foams practical for such applications as: 1) Potting (where heat dissipation is not to be a problem)—a) to give unit strength, b) to insulate wires, and c) to reduce ambient temperature and humidity oscillatory effects on electronic components. 2) Fields which require electromagnetic transparency —a) dome protectors for radar and television installations, and b) X-ray tables which permit picture taking from all angles without having to disturb the patient.

"In addition, polyurethanes may be used as a binder and/or a matrix for holding other materials, thus obtaining a desired electrical transmission effect. Thus, it has been used to advantage in molding electromagnetic lenses and as a vehicle for molding high efficiency electromagnetic energy absorbers.

"Polyurethanes have and will see wide service in the electronics industry. It is becoming especially useful in this, the space age."

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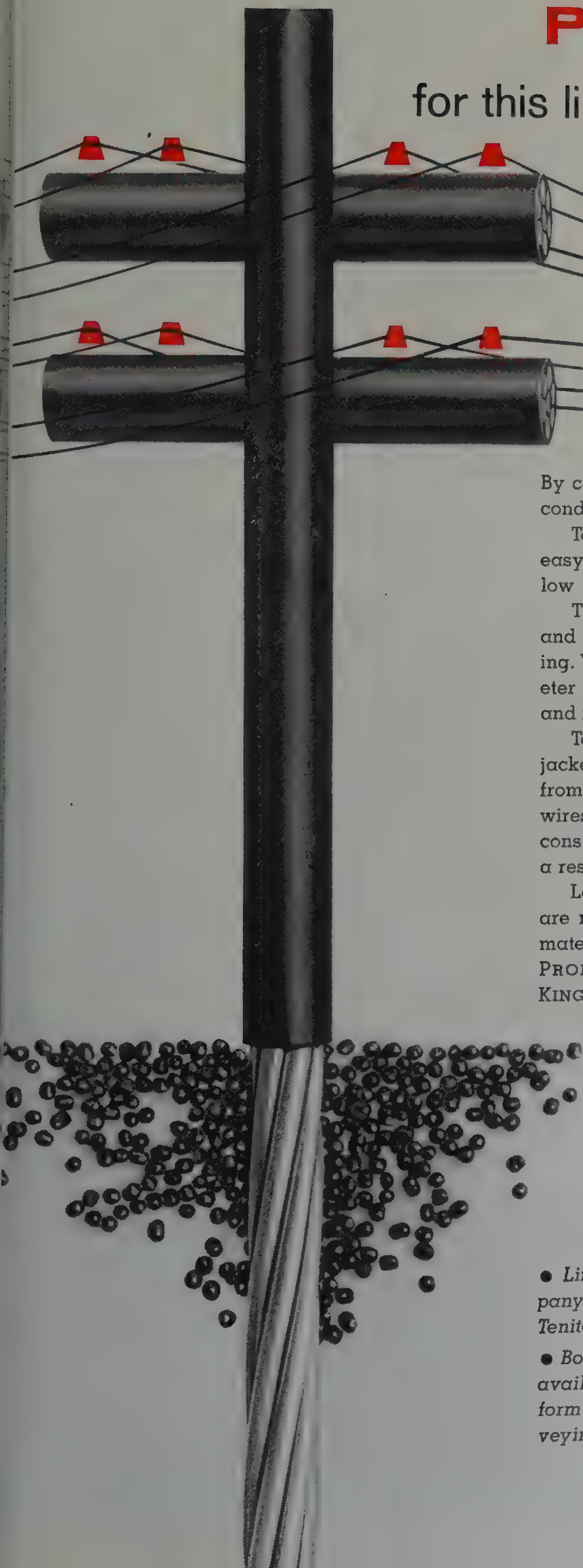
TENITE POLYETHYLENE

for this lightweight, durable line wire...



By covering this ACSR line wire with Tenite Polyethylene, Anaconda meets the needs of both lineman and engineer.

To the lineman, this covering means wire that is especially easy to handle—light in weight, fast stripping and flexible even at low temperatures. Its sleek finish creates no pulling problems.

The engineer appreciates its resistance to weather, abrasion and heat, its good dielectric strength and freedom from festooning. With insulation of tough Tenite Polyethylene, a smaller diameter is made possible which offers less area for wind resistance and ice loading. Also, the lighter cable permits wider pole spans.

Tenite Polyethylene, an Eastman plastic, is easily extruded as jacketing or primary insulation for many diverse applications, from coaxials to control cables, from TV lead-ins to telephone wires. For high-frequency service, where a very low dielectric constant is needed, this versatile material may be "foamed," with a resulting dielectric constant as low as 1.5.

Leading wire and cable manufacturers throughout the country are now using Tenite Polyethylene as jacketing and insulating material. For further information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

TENITE®

POLYETHYLENE

an Eastman plastic

- *Line wire manufactured by Anaconda Wire and Cable Company, 25 Broadway, New York 4, N. Y. Covering extruded of Tenite Polyethylene.*
- *Both natural and black electrical grade Tenite Polyethylene are available to cable manufacturers in a unique spherical pellet form which flows freely in the extrusion process and in "airveying" of bulk shipments from truck to bin.*


NOW!
What industry has been waiting for . . .
TRUE HIGH-TEMPERATURE HERMETIC SEALS
Helium leakage rate cc/sec. less than
2 x 10-10 after severe environmental tests.

MYCALEX makes big news in high-temperature precision-molded insulation

SUPRAMICA® 620 "BB" ceramoplastic

This new ceramoplastic insulation, *operating to 1200°F.*, delivers superior performance and improved accuracy . . . plus a combination of previously unattainable properties needed by engineers and designers.

SUPRAMICA 620 "BB" ceramoplastic is the most advanced ceramoplastic ever developed—a major achievement by the research laboratories of MYCALEX CORPORATION OF AMERICA—and newest member of an extraordinary family of versatile electronic and electrical insulation materials.

If you need a precision-molded material with total dimensional stability even under the most adverse thermal cycling, operating at high temperatures . . . or a material with indefinite shelf-life . . . we suggest you get the facts about SUPRAMICA 620 "BB" ceramoplastic . . . which is superior in quality but competitively priced in quantity with less versatile insulation materials. *And* remember that SUPRAMICA 620 "BB" ceramoplastic is backed by MYCALEX CORPORATION OF AMERICA'S reputation for quality.

- **Maximum temperature endurance—1200° F. (unstressed)**
  Heat distortion temperature—1100° F. (ASTM D648-264 PSI)
- **Absolute hermetic seals achieved directly during the molding cycle.**
- **SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.**
- **Impervious to humidity, oil, water, and organic solvents. Resists nuclear radiation.**
- **SUPRAMICA 620 "BB" ceramoplastic will not carbonize.**
- **Thermal expansion factor matches many metals and alloys.**
- **New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, ⅛" thickness per ASTM D-149.**

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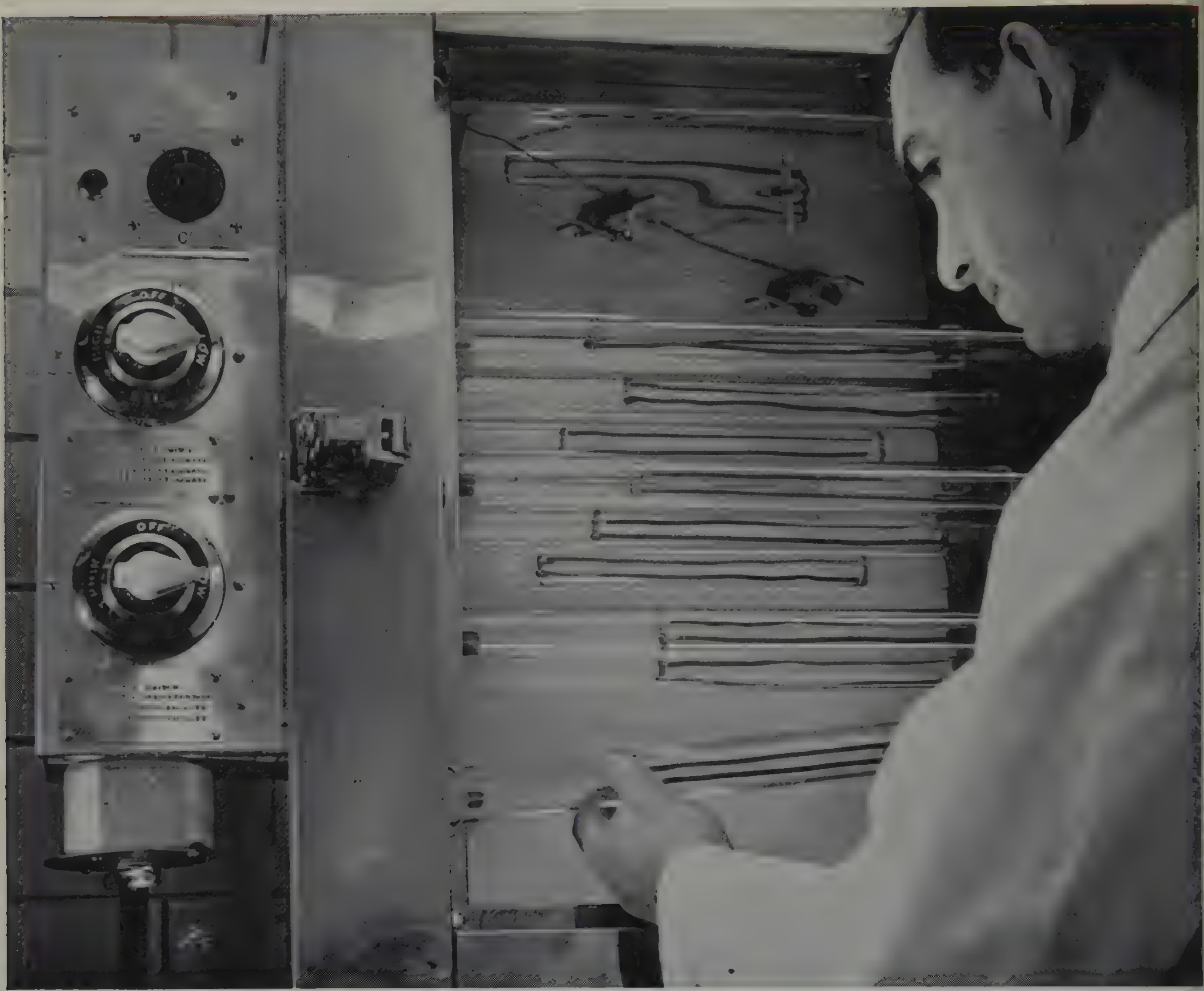
WHAT'S NEWS IN ENJAY TECHNICAL SERVICE



Enjay helps reduce cost of 90°C vinyl wire insulation...

An important part of Enjay Technical Service is developing useful new products that reduce costs, yet maintain performance. Ditridecyl phthalate for use in plasticizing vinyl wire insulation is a good example of this research activity. By tests, such as the oven aging shown above, Enjay was able to prove that DTDP, made from Enjay tridecyl alcohol, performs as an efficient, non-volatile plasticizer for 90°C wire – yet reduces plasticizer cost.

Test results, at right, show that the insulation exceeds the U.L. Specifications.

Enjay research facilities and technical skills are available to customers in the vinyl wire, film and sheeting industries.

If you would like to receive a free copy of our new Technical Bulletin No. 20 on Enjay oxo alcohol for plasticizers, write to 15 West 51st Street, New York 19, N. Y.

TEST RESULTS: 7 DAYS @ 121°C

	U. L. Specification Minimum	DTDP Plasticizer
Elongation	65% retention	100% retention
Tensile Strength	65% retention	101% retention
Dielectric Strength	50% retention	127% retention
Insulation Resistance*	.01 megohm based on 1000 ft.	0.36 megohm based on 1000 ft.

* 1 day and 7 days @ 113°C.

ENJAY
PETROCHEMICALS

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

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Pixilated Patents

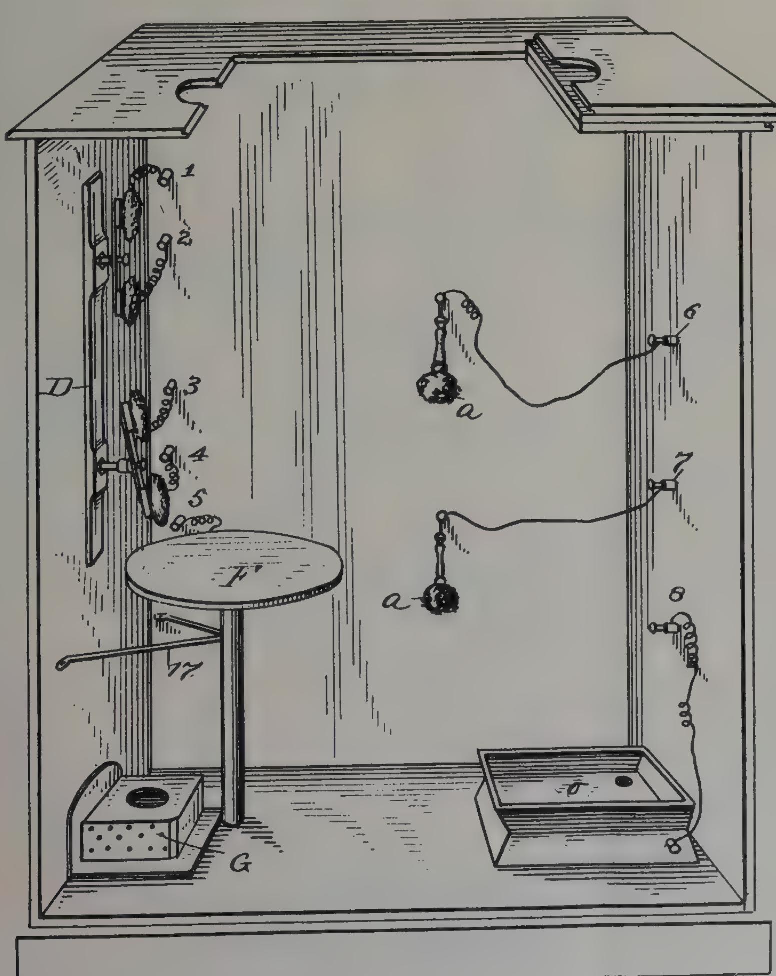
By *Mike Rivise*

Fifty-second in a series of odd and interesting inventions in the electrionics field from the files of the U.S. Patent Office.

The patent this month concerns an improved electric chair. The inventors, Abiel W. K. Andrews, of Binghampton, and Cyrus R. Teed, of Syracuse, N. Y., described it as "a new method of applying electrical currents for the cure of diseases." However, one gets the impression from reading the patent that it was designed to wipe out the patient . . . and in a somewhat artistic manner. For the patent states that the "improved method consists in causing the currents to enter the body at several points, and to converge and leave at a less number of points, or to enter at a less number and to diverge in the body and leave at a greater number of points."

Concern for those applying the electricity is evidenced by the incorporation of "improved devices for holding and manipulating the electrodes, whereby they may be more conveniently and accurately applied to the body of the patient." On the other hand, the inventors also seemed to show sympathy for the patient by including "an improved foot-support adapted to be used as an electrode, or to keep the feet of the patient warm." Perhaps they recognized that cold feet might be common among patients about to be seated on this chair.

One of the outstanding features of this product was the device for "dividing, converging, and diverging the electric currents in the body of the patient." The ability to send the current between different parts of the body was thought by the inventors to be particularly desirable because of a theory which is stated to be "that the currents from sound and healthy portions of the body carry vital energies to diseased portions, and thereby produce remedial effects. On the other hand, it has been found that the current entering the body at a diseased point may carry the abnormal and unhealthy activities to other and sound portions of the body, and thereby derange and disturb them, but by their division and dispersal through several healthy parts this liability is greatly lessened or entirely removed."



European Insulation Report

Ed. Note: The author of this monthly European report is a well-known insulation expert associated with a large European electrical manufacturer. Although it is necessary that his identity not be revealed at this time, correspondence may be exchanged with him by writing *European Editor, Insulation, Box 270, Libertyville, Illinois.*

New Insulation Materials

By Dr. L. Hahn, Die Technik, Vol. 15 No. 12, December 1960, pp. 781-785. Original title: Neue elektrische Isolierstoffe.

The paper is not of outstanding importance since nothing new is offered in this short survey of modern insulation materials but part of the paper gives a series of general views on the cooperation of chemical and electrical engineers, scientists, designers, and manufacturers working with these materials.

The new polymerized resins offer many possibilities and require an exact knowledge of the material by all concerned.

The author demands a precise definition of the properties necessary for the designer and workshop. He also reminds the chemists to publish more measured results and properties to cover all possible stresses. He seems to forget, however, that a functional test shows only the weak points and especially the noticeable peculiarities of an application. Tables showing physical, chemical, and electrical properties can give only a clue for the selection of a material and allow its performance to be predicted and the designer and manufacturer can use a specification only when fixed conditions are known.

The author rightly stresses that today it is indispensable that everyone concerned should have a precise knowledge of materials under all conditions so that the optimum solution to a problem may be found.

Swiss Conference Papers

At the conference of the "Schweizerischer Elektrotechnischer Verein" (Swiss Electrotechnical Association), on new electrical techniques, held on September 16th, 1960, a number of interesting papers concerning synthetics as insulations were read. *The papers appeared in the "Bulletin des schweizerischen Vereins," Vol. 51 No. 24 (3rd December 1960) pp. 1245-1256, No. 26 (31st December 1960) pp. 1330-1340 and 1340-1344 Vol. 52 No. 1 pp. 1-8.*

Dr. G. de Senachens, director of Factory for Insulation Materials, Breitenbach (S.O.), Switzerland, spoke first about "Plastic Materials Used in the Insulation of Wires and Cables." (Original title: Les matieres plastiques utilisées dans l'isolement des fils et des câbles.)

Here as in the following papers it was emphasized that no insulation, including the latest, has all the necessary properties of an ideal material. The requirements necessary for a material used for the insulation of wires and cables are, in the author's opinion:

General properties: good mechanical properties in the cold state, i.e., compressive and tensile strength; chemical and physical stability up to 70°C; easily workable; non-flammable; absence of mechanical stress in the structure of the material; reasonably priced.

Particular requirements for light current conductors: low dielectric constant; low dielectric losses at all frequencies; very high dielectric strength. For heavy current conductors good heat conductivity is also required.

For the exterior covering of wires and cables, the following are also required: resistance to water, steam, oil, chemicals, oxidation etc.; small specific gravity; good mechanical strength.

These requirements are mostly met by plastic materials which are therefore suitable as substitutes for the various classes of paper, rubber, and lead, even if the centering of the conductors is difficult. From these synthetics at our disposal, only the thermoplastics are in general use and these alone are treated in this paper. Elastomers are sometimes used in cable sheathing but thermosetting resins not at all.

The properties of PVC and polyethylene were given. The initial disadvantages of PVC which were water absorbtion in d-c conductors and the appearance of cracks under mechanical stress, as shown by ultraviolet and chemical investigation, have now been largely overcome.

When using PVC for cable sheathing, one must try to use as pure a resin as possible, mixed with a stabilizer to inhibit thermal decomposition, a pigment to absorb ultraviolet light, and a plasticizer which must be non-volatile, a good mixer with PVC, and not liable to oxidation. Development still goes on without interruption. The author remembered also as an example that Swiss industry recently produced for the first time a wire with an insulation which had a multicolored spiral surface.

The properties of low-pressure and high-pressure polyethylene were examined in relation to cable and conductor insulation. There also was a fundamental survey of the possibilities of irradiated polyethylene, polypropylene, "Styroflex," and "Teflon." The author has the view that at least part of the cable sheathing can be replaced with a plastic or elastomer, and with a modified cable, even a complete replacement is possible. As an example he gives the "Alphet" and "Stalpeth" cables. See (Hasenhorst H: Nachrichtenkalund-leitungen mit Kunststoffen. Siemens Zeitschrift Vol. 32 (1958) No. 4, pp. 182-187).

In figures 1 through 10, the usual

wire and cable insulations used for telecommunications in Switzerland are shown.

"Use of Synthetics for the Production of Moulded Components" by Dr. G. O. Grimm (Wiedemann AG, Rapperswil, Switzerland). Original title: "Verwendung von Kunststoffen bei der Herstellung von Formstücken."

The author states that three-fourths of all moulded components for apparatus are produced from synthetic resins made from polystyrene, phenolic, and amino plastics. The many other synthetics known today will generally not stand up to the higher requirements needed for moulded components. When one or another material is better in one property, it is the compromise, i.e. the sum of all the relevant properties, which is important for moulding materials. By extrusion or pressure all shrinkage (tolerances, stress in structure) must be eliminated. The grain orientation during this forming process is also important because strength varies with the direction in the proportion 1:2 as a result.

The author also complains that not enough information and service experience is available.

In particular information about mechanical properties at higher temperatures is absent. The published values are too high, because the methods of measuring (heat distortion, temperature, Martens) do not take into account the different moduli of elasticity. The temperature is raised so quickly that no steady state condition is possible.

The results were measured in an ideal test which is scarcely applicable to the strength when formed. Diagrams are wanted of strength, temperature and time.

The thermoplastic group gives good dielectric properties but the mechanical strength with aging at a high temperature is very low. These values are better with the Duroplastics.

Since, for these new materials, experience in their use is not available and new materials which are very promising for various purposes are continually coming onto the market, it is advisable for the customer to do his own research, especially the carrying out of aging tests on moulded components for each batch of formed and extruded parts. In figure 2 the results of aging tests in the open air are shown.

New synthetics will be discovered in the future but today's materials will be brought into mass production. Also, in the future it will not be possible to renounce well planned production and the correct technical use of a particular synthetic.

An important contribution was delivered by Dr. H. Künzler (Chief of the material test section of the Swiss PTT) in his paper on Experience with Synthetics (Original title: "Erfahrungen mit Kunststoffen").

Since 1942 telephone apparatus housings have been made from black phenolic resin with much success in practice. However the surface loses its glaze through the action of the sun's rays, often becoming unpleasant. The material is brittle so that occasionally breakages occur—a thick section is necessary and therefore, the pressing becomes unwieldy.

The tolerances for exchangeable parts (e.g. earpieces) are obtained only with difficulty.

In the case of cream colored housings made from melamine resin, cracks appeared because of stresses caused by shrinkage of the material and fractures because of its brittleness.

Recently tests have been carried out with grey, mechanically strong melamine-phenolic resin mixture on moulded parts which undergo a heating cycle. A thermoplastic is being sought which will allow the housing to be extruded instead of pressed.

In the case of plugs, sockets, etc., housings from phenolic plastics and

Figure 1, wire for installations: 1. copper wire, 2. PVC insulation.

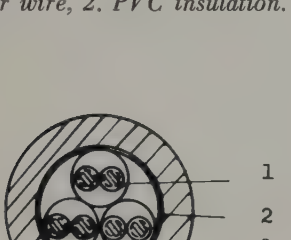


Figure 2, cable for telephone exchange: 1. copper wire, 2. a layer of paper, 3. PVC insulation.

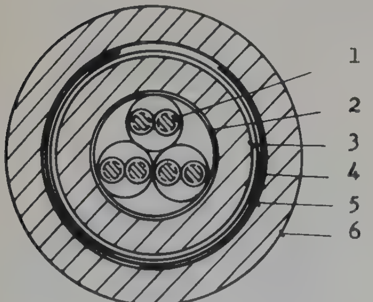


Figure 3, armoured supply cable: 1. copper wire, 2. a layer of paper, 3. PVC, 4. cotton tape, 5. sealed steel wrapping, 6. PVC.

Figure 4, feeder cable: 1. copper wire, 2. polyethylene insulation.

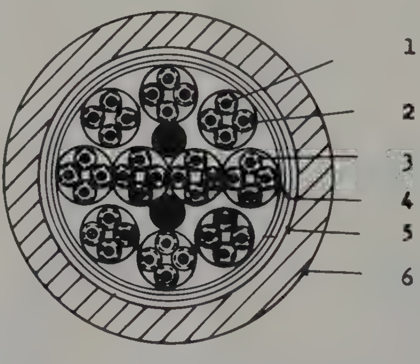


Figure 5, telephonic cable: 1. copper wire, 2. polyethylene insulation, 3. PVC insulation, 4. terephthalate tape, 5. layer of paper, 6. PVC.

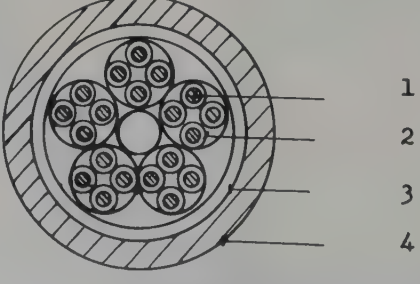


Figure 6, telephonic cable type F: 1. copper wire, 2. polyethylene insulation, 3. terephthalate tape, 4. PVC.

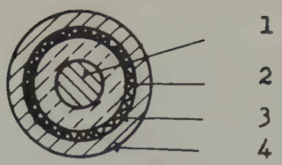


Figure 7, coaxial cable: 1. stranded copper wire, 2. polyethylene insulation, 3. static shield, 4. PVC.

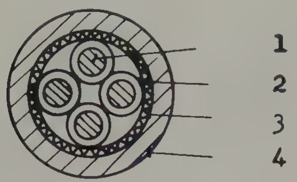


Figure 8, microphone cable: 1. stranded copper wire, 2. polyethylene insulation, 3. static shield, 4. PVC.

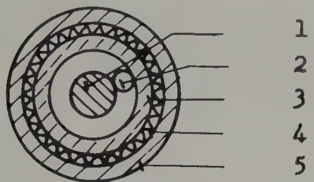


Figure 9, high-frequency cable: 1. enameled wire, 2. spiral of "Styroflex," 3. polyethylene insulation, 4. static shield, 5. PVC.

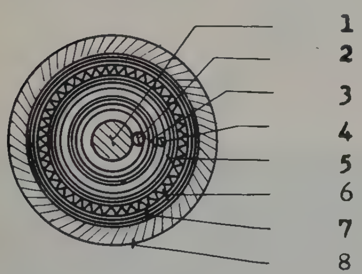


Figure 10, high frequency coaxial cable: 1. silvered copper wire, 2. spiral of "Teflon," 3. Teflon tape, 4. spiral of Teflon, 5. Teflon tape, 6. static shield, 7. Teflon tape, 8. tressing of glass fibre impregnated with silicone.

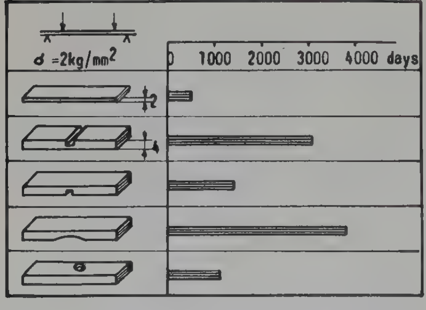


Figure 11, the results of aging tests on phenolic resin bars in open air under a bending strength of 2 kg/mm².

amino-plastics have stood up well both in test and in service.

In the case of moving parts, specimens of a tough polyamide, with very good abrasion strength and frictional properties, stood up to friction and pressure both in tests and in service. Against other moving parts it is less noisy than metallic components but greater tolerances are necessary.

Since 1955 there has been a type of condenser in very successful service which has a sheet metal housing and is covered with an epoxy resin. In an earlier type, the paper roll was in a synthetic resin cup which was closed with a cap of the same material but moisture percolated through the cup.

Out of his rich experience, the author relates his experience using different wire insulations in telephone service.

The Swiss PTT was one of the first to allow the use of PVC insulated wires in their circuits. The results are very good and the improvement undoubted. However these points must be noted: No plasticizer which might evaporate and affect the relay contacts was used. The end of the PVC insulation must not be permitted to pull back onto the solder. It is also important to observe its thermal stability. At present, the PTT uses 0.6 mm thick wire, of which the PVC is so stretched that 2 to 3 colors describe a spiral and the borders between colors are sharply defined. The plasticizer must be of such a kind that it inhibits the formation of fungus.

The ordinary domestic mouse likes softer synthetics more than the stiffer polyethylene. Mice repellant substance in a cable sheath provides only a little protection.

PVC covers for cables which the telephone user can use both for speaking and playing with, are not suitable since they break. For weatherproof cable, soot must be mixed with the PVC and the black color of the cable causes complaints when it is used for domestic purposes. Therefore, brighter designs must arrive as soon as possible.

PVC covering is also used frequently as a protection for lead sheathing. Nevertheless difficulty is caused at the junction of the PVC and lead. At the moment a bituminous layer arranged between the lead and the PVC is being investigated. This will prevent the penetration of water and a lead water contact at the junction of the PVC. Also the question of the grounding of the cable sheath is not yet solved satisfactorily.

Therefore the time when the present fully synthetic cable, without a lead sheath, becomes fully acceptable remains in the future.

In conclusion, it can be said that if any breakdowns in use occur with synthetics, it means that they have not been used in the right places or the aging properties at the time of manufacture were not fully known. The first cause of defects can be easily avoided and the second is a consequence of hurried development. This can not be avoided because the results of long drawn out aging tests can not be awaited without a slowing down of progress.

(The European Editor still has the view that many weaknesses can be determined only from functional tests so that the number of faults in service will be reduced to a minimum.)

Largest Resistor Voltage Divider

Probably the largest precision resistor voltage divider built to date, this network was built on special order for a Texas firm (everything's bigger in Texas) as a precision 30 megohm 100-to-1 divider to operate at 30,000 volts with .05 accuracy. Small resistor is solely for comparison. Manufacturer is Resistance Products Co., Harrisburg, Pa.

Urethanes, Polysulfides, Phenolics, Polystyrenes, And Polybutadienes for Use as Embedding Materials

By Charles A. Harper, Materials & Processes Section, Engineering, Air Arm Div., Westinghouse Electric Corp., Baltimore

Editor's Note: *A considerable amount of information has been published on the more common embedding materials such as epoxies. However, although not widely publicized, some of the lesser known embedding products do deserve broader editorial coverage since their properties make them very suitable for some applications. This article is based on material in a book by Mr. Harper, to be published about May of this year, titled "Electronic Packaging with Resins—A Practical Guide for Materials and Manufacturing Techniques," McGraw-Hill Book Co., Inc.*

Urethane Resins

Urethane resins can be formulated over a wide range of hardness. They can be used where resilience, shock, and impact properties are required in combination with good electrical properties. Although not generally required for electronic packaging applications, it is interesting to note that another excellent property of cured urethane rubbers is their excellent abrasion resistance. For this reason, urethanes find considerable use in mechanical applications. Because of the numerous chemicals which can be used in reactions for producing urethanes, and the various names which are used for these chemicals, urethane resins are often interchangeably referred to as isocyanates, diisocyanates, polyurethanes, polyester diisocyanates, and polyether diisocyanates. Also, because the resins can be formulated to produce resilient or rubber type cured parts, the end products are also often referred to as urethane rubbers or urethane elastomers.

There are two major urethane systems, namely, one shot and prepolymer. With the one shot system, the complete reaction between the diisocyanate and the other reactants is carried out by the user. With the prepolymer system, the diisocyanate and the other reactants are partially reacted before being shipped to the end user. In both cases, a catalyst is used.

The one shot system involves raw diisocyanates, which are somewhat toxic and irritating. On the other hand, the prepolymer system has already been partially reacted, so that there is no significant problem with objectionable vapors and fumes. Thus, the prepolymer system is perhaps the most popular with the end user. The one shot system, however, often reacts faster and more completely and

Table 1—Properties of Typical Cured Prepolymer Urethane Resins

	Typical Compound*		
Property	A	B	C
Color	Clear Amber	Clear	Clear Amber
Sp. Gr.	1.16	1.16	1.15
Hardness, Shore D	85	79	82
Tensile, psi	8700	3575	4189
Elong., %	10	170	10
Water Absorp.	0.53	0.68	0.22
Shrinkage, in/in	0.022	0.022	0.023
Impact (ft. lbs.) in notch	0.84		
Dielectric Constant	3.25	4.6	3.54
Power Factor	0.021	0.0245	0.029
Volume Resistivity, ohm-cm	10^{12}	10^{12}	10^{12}

**Based on Hysol 8530-Hysol 8531 resins. Hysol Corp.*

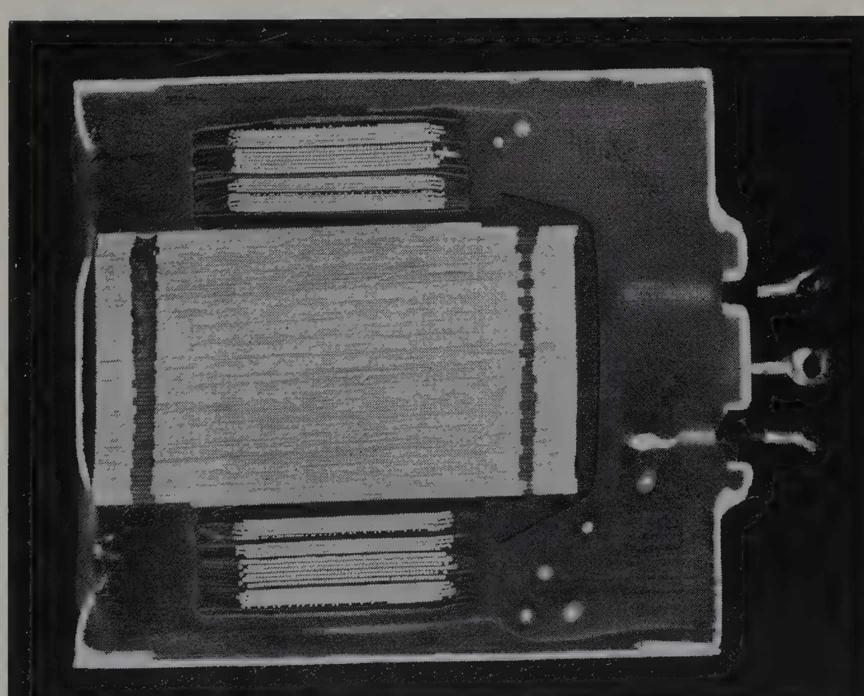


Figure 1, cross section of a transformer potted with urethane. (Hysol Corp., resin 2085.)

Table 2—Properties of Cured One Shot Urethane Resins*

Physical Properties	DC-1	DC-2	DC-3	DC-4
	Formulations			
Liquid				
Specific Gravity, 50°C	1.081	1.025 (25°C)	1.070	1.027
Viscosity, without Catalyst				
at 25° C, cps	10,000	—	4,000	—
at 50°C, cps	2,000	100**	1,000	200**
Solid				
Specific Gravity, 25°C	1.140	1.075	1.128	1.1085
Shrinkage, on Cure, %	5±0.5	5±0.5	5±0.5	5±0.5
Hardness (Shore A)	100	60	99	70
Tensile Strength, psi	5,284	611	1,250	790
Elongation, at break, %	—	450	—	225
Heat Distortion temp.	62°C	—	—	—
Water Absorption, %	0.03	0.12	0.07	0.10
Dimensional Increase— after 24 hrs. in water, inches/inch	0.0015	0.0015	0.0010	0.0015
Gardner Impact, ft. lbs.				
at 25°C	1.30	No fracture	0.75	No fracture
at 50°C	0.60	0.60	0.60	0.80
Abrasion-Taber, loss in gms. (Wheel H-22, 2000 cycles)	0.39	0.39	0.71	0.18
Electrical Properties***				
Dielectric Strength, volts/mil	409	365	390	441
Dielectric Constant	3.04	3.61	3.01	3.36
Power Factor, 1000 cycles/sec.	0.0050	0.1020	0.0090	0.0370
Chemical Resistance				
Strong Bases	Very good	Very good	Very good	Very good
Strong Acids	Very good	Very good	Very good	Very good
Oils and Gasoline	Excellent	Excellent	Excellent	Excellent
Aliphatic Solvents	Very good	Very good	Very good	Very good
Aromatic Solvents	Poor	Poor	Poor	Poor
Chlorinated Compounds	Poor	Poor	Poor	Poor

**Based on formulations using Allied Chemical and Dye Corp. diisocyanates.*
***Viscosities of both DC-2 and DC-4 increase continuously from the time of initial isocyanate-castor oil reaction. The figure given is the viscosity after 10 minutes reaction time and merely indicates the range to be expected.*
****MIL-L-16923B, Insulating Compounds. Electrical, Embedding. DC-1 and DC-3 meet the requirements for Type B on the above tests. DC-2 and DC-4 meet the requirements for Type C on the above tests.*

Table 3—Typical Physical Properties of LP-3 Polysulfide Converted by the GMF-DPG and TNB Cures*

	GMF-DPG Cure	TNB Cure
Compounding Recipes, Parts		
"Thiokol" LP-3	100	100
Titanox A**	50	50
2,4,6,—Trinitrobenzene (TNB)	—	4
p-Quinonedioxime (GMF)	7	—
Diphenylguanidine (DPG)	3	3
Sulfur	—	1
Vulcanizate Properties (Cured 16 Hr. at 158°F)		
Shore A sheet hardness	40	40
300% Modulus, lb/sq in	290	180
Tensile strength, lb/sq in	350	250
Elongation, %	400	600
Compression set, % *** (2 hrs. at 158°F, 25% comp.)	40	40

**Based on formulations courtesy Thiokol Chemical Corp.*
***Titanium Pigments Inc.*
****ASTM method D 395-49T, method B*

is considered by some to give a more complete cure and hence, a better product, both electrically and physically. The high exotherm produced in the one shot system can sometimes cause trouble if the size of the casting is large or if the reaction gets hot enough to affect the materials or components within the electronic package.

Prepolymer Urethane Resin Systems—Their terminal groups react readily with water and water vapor. Hence, care is necessary to prevent contact with moisture. If containers of the resin are left exposed to the atmosphere, a surface skin will result. This skin can be removed with no damage to the balance of the liquid. However, care should be exercised in resealing urethane resin containers immediately after use.

Urethane resins sometimes contain a certain amount of carbon dioxide resulting from reaction with trace amounts of water. To produce bubble-free castings, this gas must be removed prior to cure. Application of heat and vacuum will usually accomplish this in a short period of time. Properties of typical cured prepolymer urethane resins are given in table 1.

One Shot Urethane Resin Systems—Properties of some cured resins are given in table 2. Preparation of one shot resin systems is critical. This is perhaps best demonstrated by describing the methods of preparation for one of the systems listed in table 2 (formulation DC-1).

Formulation DC-1. Heat 119 parts of Nacconate 300 above its melting point (50° to 55°C) but avoid local concentration of heat. Gradually add 100 parts of an anhydrous grade of castor oil to the melted Nacconate 300 in a dry inert atmosphere (i.e. dry nitrogen) and mix for one hour, maintaining the temperature of the reactants between 60-70°C. It may be necessary to apply heat to maintain this temperature when working with gram quantities. However, when using larger quantities, the heat of reaction will cause the temperature to rise above the indicated range, and cooling may become necessary.

After the cooking cycle has been completed, reduce the pressure in the

eaction vessel to 5 mm of mercury or 30 minutes while holding the temperature constant at 60°C to remove dissolved gases.

Add 4.4 parts of ethyl diethanolamine catalyst and mix vigorously for two minutes. Stop agitation and degas the liquid as described in the previous paragraph for five minutes prior to pouring into molds.

DC-1 is cured at 105° for six hours. It has a room temperature pot life of about one hour after addition of catalyst. Without catalyst, storage life is about two weeks.

Table 4—Properties of a Typical Cured Polybutadiene Resin*

	Curing Condition			
	6 Hr. 245°C	18 Hr. 245°C	6 Hr. 262°C	18 Hr. 262°C
Density, gram/cc	0.979	0.990	0.991	0.993
Shore D hardness	73	87	84	88
Impact, ft. lb., Izod	0.89	0.280	0.350	0.218
Flex strength, lb/sq in	1315	8200	9050	5400
Tensile, lb/sq in	1270	5400	4970	2800
Elongation, %	18	3	4	1.3
Heat Dist. Temp., °C	—	91	64	205
Deform. under load, %	—	1.30	4.97	0.3

**Based on a formulation described by Crouch and Shotton, Industrial and Engineering Chemistry, October, 1955.*

Polysulfide Rubber Embedding Resins

Polysulfide rubbers are available as liquids suitable for use in certain embedded electronic packaging applications. The cured polysulfide rubber product is flexible, and has excellent resistance to solvents, oxidation, ozone, and weathering. Also, this product has low gas permeability and good electrical insulation properties at temperatures between about —65°F to 300°F. At 25°C, the cured polysulfide rubber has a volume resistivity of 10^9 ohm-centimeters, and a one megacycle dielectric constant of 7.5. One application for which polysulfide embedding resins have been widely used is the potting of electrical connectors.

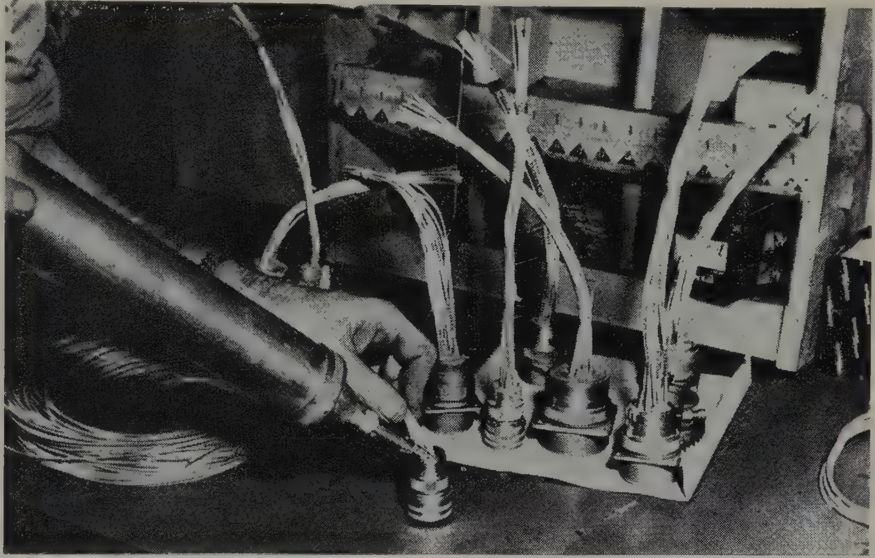


Figure 2, potting aircraft electrical connectors with a polysulfide liquid polymer. (Thiokol Chemical Corp., resin LP-2.)

Chemically, polysulfide rubbers are organic compounds containing sulfur, with the sulfur groups in the polymer chain being known as mercaptan (-SH) groups. An average structure for a polysulfide may be represented as follows:

$$HS\text{-}(C_2H_4\text{-}O\text{-}CH_2\text{-}O\text{-}C_2H_4\text{-}S\text{-}S)_n\text{-}C_2H_4\text{-}O\text{-}C_2H_4\text{-}SH$$

Polysulfide resins have the mildly characteristic odor of sulfur or mercaptans. Certain of the resins are supplier formulated so that the user does not know all of the ingredients. However, Thiokol LP-3 is supplied as an unformulated base resin, and for purposes of describing the basic nature of these resins, some information concerning the LP-3 resin and polymer is given.

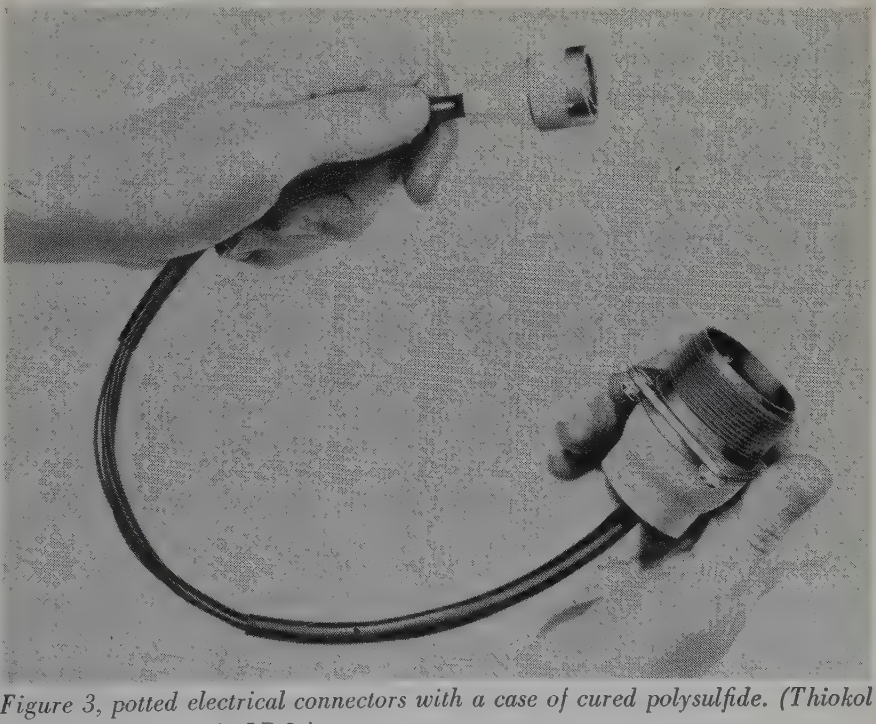


Figure 3, potted electrical connectors with a case of cured polysulfide. (Thiokol Chemical Corp., resin LP-2.)

As with most liquid resins, control of viscosity of the LP-3 resin is possible by temperature control. Conver-

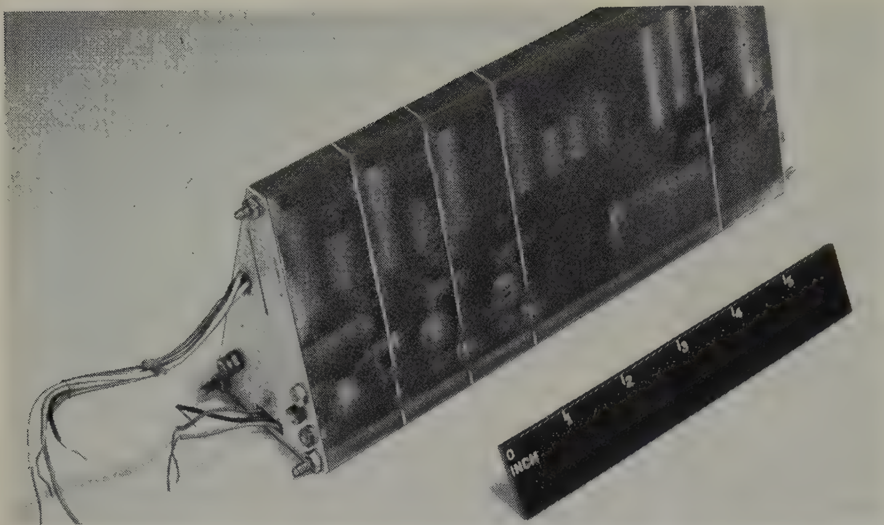


Figure 4, amplifier circuit potted in a polystyrene casting resin having a dielectric constant of 2.32 and a dissipation factor of 0.0006. (Emerson and Cuming, Inc., "Stycast" TPM-3 resin.)

Table 5—Properties[1] of a Cured Hydrocarbon Thermosetting Resin

Appearance	Transparent
Refractive Index	1.563
Density	1.01-1.03
Flex. Strength, psi	8,500-14,000
Flex. Modulus, psi	3.3-3.7 x 10^5
Heat Distor. Temp., °F	186-280
H_2O Absorp. (% in 24 hrs. immersion at 72°F)	0.0-0.5
Volume Resistivity[2], ohm–cm.	$<$ 6.56 x 10^{16}
Dielectric Constant at 10^3 cycles	2.53
Dielectric Constant at 10^6 cycles	2.53
Power Factor at 10^3 cycles	0.0011
Power Factor at 10^6 cycles	0.0014
Radar Frequency, 9375 megacycles	
Dielectric Constant	2.46
Loss Tangent	0.007
Arc Resistance, seconds	78
Dielectric Strength, volts/mil, short time, ⅛" specimen	808
Surface Resistivity at 50% R.H., ohms	31.0 x 10^{12}
Surface Resistivity at 96% R.H., ohms	24.5 x 10^{12}

[1]*ASTM Test Methods; based on a formulation described by Clark and Adams, 2nd National Conference on the Application of Electrical Insulation, December, 1959.*
[2]*Limit of instrument.*

sion of the liquid LP-3 polymer to the solid rubber material is accomplished by the use of oxidizing agents. Table 3 shows two formulations and the physical properties of the cured part.

Conversion of these polymers from the liquid to tough rubber state is somewhat exothermic and heat is not necessary. However, heat, high humidity, alkalinity and sulfur accelerate the reaction. Acids retard cure. Compounds based on these liquid polysulfides are used in many applications where intermediate electrical properties are required. Transformer coatings and electrical connectors for aircraft, guided missiles, and other equipment are examples of this type of application.

Fillers are required in liquid polysulfide for strength and improved electrical properties. Non-black fillers, such as zinc sulfide, York Whiting, lithopone, Cah-O-Sil, and Burgess Pigment No. 20, at a loading of 15 to 50 parts, are recommended. Tight cures are essential for optimum electrical properties. Incorporation of 0.1 to 0 5 part of sulfur results in firmer cures, which give slightly improved resistivity.

In general, plasticizers should not be used because they appear to degrade electrical properties. In applications where compounds of high fluidity are required, solvents such as toluene or xylene are recommended for reducing viscosity. The type of curing agent used also has a pronounced effect on the electrical properties. Compounds with poorer electrical properties are obtained with cumene hydroperoxide than with lead dioxide cures, as an example.

The oil and solvent resistance properties of polysulfide rubbers made them useful for electronic packaging in areas involving oils and fuels.

Phenolic Resins

Phenolic resins are not used to a large degree for embedding electrical assemblies primarily due to the effects of the acid catalyst on corrosion of electrical parts, shrinkage, and the water vapor given off in the reaction. Phenolic casting resins are supplied as liquid syrups and usually require heat in order to solidify. There are two classes of phenolic casting resins, based on method of curing. The first is the accelerator type which utilizes a catalyst for shortening the curing cycle. The second class is the non-accelerator class which utilizes heat without a catalyst, and therefore has a considerably longer curing cycle.

Among the attributes of phenolic casting resins are their relatively low cost and their exceptionally good machinability.

Polystyrene Resins

For embedment type applications requiring low electrical losses, polystyrene or styrene type resins are often used. Various styrene modifications are employed such as the styrene monomer itself, the partially polymerized styrene monomer or high styrene content polyester modifications. The attributes of the styrene type resins are their excellent dielec-

c properties for high frequency plications such as low and equally ntrolled dielectric constant, low dis- ation factor, and good electrical sistance. Styrene type resins are not dely used for embedding applica- ns because of certain practical nitations. Curing cycles are nor- ally long and the useful temperature nge is low. They are generally use- l only below 125°C. They have a gh shrinkage and therefore a tend- cy to crack during the curing eration. Their thermal expansion is so high, which increases the tend- cy to crack both during the curing eration and thermal shock cycling. ue to the vapor pressure of the yrene, it is often difficult to make stings or embedments which do not ntain bubbles or voids. One other oblem with the styrene-type embed- ng resins is that the curing re- tion is air inhibited. That is, a sur- ce which is exposed to the air will main tacky. This can be overcome course by curing a layer of another sin on this top surface or by put- ng an aluminum sheet or some such cover over the surface during the curing reaction.

Although the above mentioned problems prevent the use of styrene-type embedment resins for many applications, the very excellent electrical properties for high frequency applications warrant their use in certain applications. The approximate value of the important electrical characteristics are a dielectric constant of 2.3-2.4 and a dissipation factor below 0.001 in the frequency range between 60 and 10^{10} cps. The dielectric strength is above 400 volts per mil, and the volume resistivity is above 10^{13} ohm-cm.

Polybutadiene Resins

Polybutadienes represent another class of resins which have some usefulness for embedded electronic packaging, but which have not been widely used. These liquid polymers of butadiene set to a viscous gel and subsequently harden to a highly cross-linked transparent resin when heated at about 500°F in the absence of air. The castings have interesting electrical properties; for example, at 10^6 cycles a dielectric constant of 2.42 and dissipation factor of less than 0.0005 are observed. They have exceptional high temperature stability, undergoing little or no deterioration at temperatures to 600°F. Typical properties of unfilled polybutadiene castings are given in table 4.

An all hydrocarbon resin which is a copolymer of butadiene and styrene containing side vinyl groups was described by Clark and Adams at the 2nd National Conference on the Application of Electrical Insulation. The base resin can be heat cured without catalyst at temperatures up to 400-500°F. Faster cures are obtainable by incorporating a cross linking monomer such as styrene or vinyl toluene, and the use of peroxide catalysts such as dicumyl peroxide or di-tertiary butyl peroxide. The general physical properties of the base resin are a transparent, almost water white color, having a room temperature viscosity of about 4,000 to 4,700 poise. The specific gravity is 0.915. Properties of the cured resin are listed in table 5.

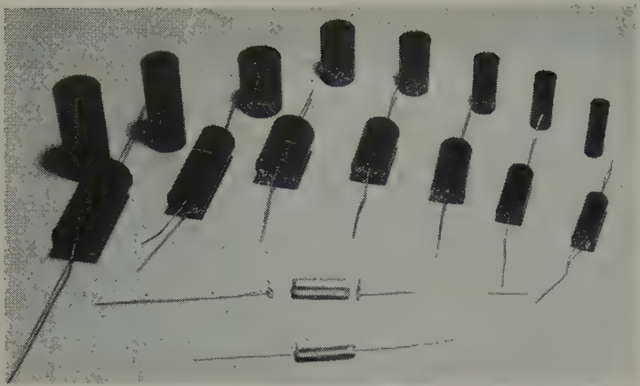


Figure 1, capacitors made by Lenkurt have wound sections encapsulated in these round molded shells.

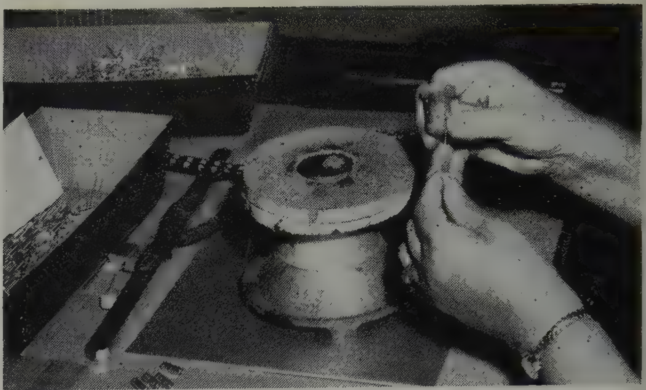


Figure 2, wire leads are dipped into liquefied solder and joined to sections.

Molded Epoxy Shell Capacitors

By Lloyd A. Dixon, Vice President, Hysol of California, Division of Hysol Corp., South El Monte, Calif., and Virgil Lorenzini, Application Engineer, Hysol Corp., Olean, N.Y.

Today, the technology of epoxy molding compounds has advanced to the point where thin-walled shells for capacitors and other electronic components can be mass-produced with assurance of high strength, uniformity, close tolerances, and freedom from voids and similar defects. Until recently, meeting all of these requirements had been difficult because of problems connected with the proper flow of the epoxy powder during the molding process.

Now, cured molded epoxy shells are obtainable with a tensile strength of 10,000 psi, flexural strength of 12,000 psi, compressive strength of 37,000 psi, heat distortion point of 150°C, and self-extinguishing characteristics per ASTM D635-56T, Mil I-16923C, and Mil T-27A.

The molding material is a granulated thermosetting epoxy powder which cures to a hard, infusible shell under heat and pressure. It has good flow for insert molding, dimensional stability, low shrinkage, and less than 0.2 percent weight loss after 400 hours at 150°C. In addition to shells for capacitors, the compound can be used to make switch plates, connector plugs, explosion-proof switchgear, coil forms, bushings, insulators, and many other parts.

Molded epoxy shells for capacitors can be supplied with wall thicknesses as low as .008-inch and to almost any desired outside diameter and length. They are either transfer or compression molded for approximately 2 minutes in flash or semi-flash type dies heated to 310°F. The molding cycle is closely controlled with regard to the closing rate of the die, the application of pressure, and the length of curing time to which the shells are subjected prior to ejection. After molding, the shells usually are tumbled to remove flash and the bottom hole is punched through.

In capacitor production, the sections are encapsulated with a suitably formulated epoxy resin to produce a unit with excellent electrical and physical properties. However, to ensure a permanent bond of resin to internal shell surfaces, no waxes or silicones are employed in the shell molding process.

Capacitor shells are molded with just one end open and therefore, encapsulation requires only one epoxy set-up cycle. This in turn provides for increased production capability with a subsequent reduction in manufacturing costs. The encapsulating resin completely seals the capacitor sections and bonds to the walls of the shell. Usually, a

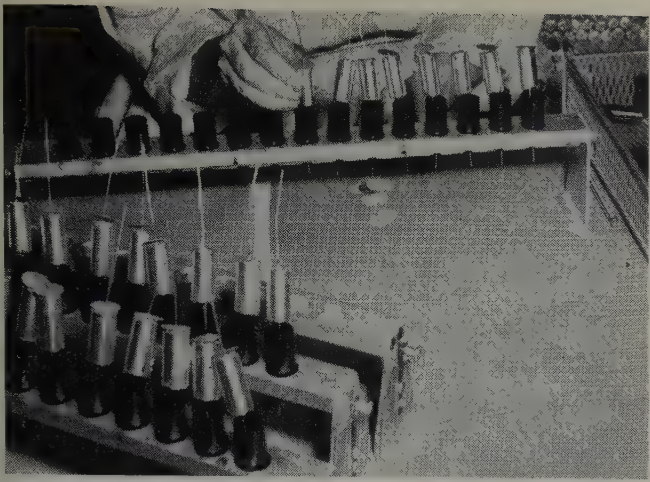


Figure 3, sections with paper discs attached are placed on top rim of shell, with wire lead set in bottom hole.

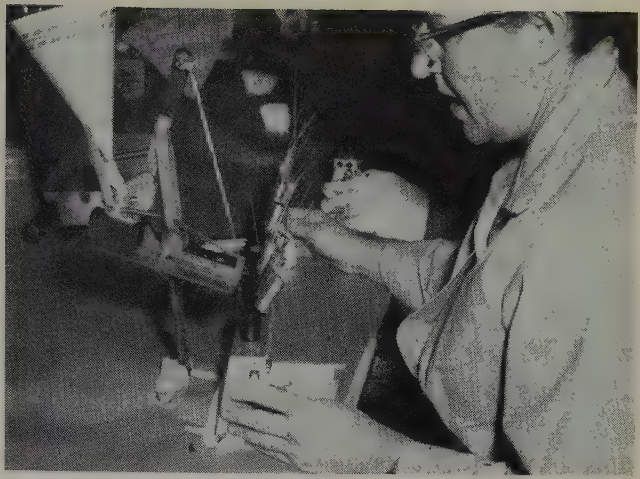


Figure 4, one-third of shell is loaded with epoxy resin by this dispensing device.

room-temperature curing resin is used, but the resin may be of the heat-cured type if production volume demands increased output or other properties are desired.

There are many different methods employed today in producing epoxy shell capacitors. To illustrate some of the techniques, two case histories have been selected—one from Lenkurt Electric Company, Inc., San Carlos, Calif., the other from Electron Products, Division of Marshall Industries, Pasadena, Calif.

Lenkurt Method

This company manufactures polystyrene core capacitors encapsulated in molded epoxy shells exclusively for installation in its own line of telephone carrier systems and auxiliary equipment. The capacitors are used primarily in the filters which pass very narrow bands of frequencies and reject all others. The filters permit many messages to be passed over a pair of wires simultaneously and therefore require extreme stability to maintain quality telephone service.

Molded shell capacitors impart the necessary high degree of quality and stability to the filters. And Lenkurt produces its own capacitors to eliminate a complicated procurement problem which would occur if the capacitors had to be purchased to the wide range of exact values required. By maintaining a sizable stock of capacitors, the company has a ready supply of any particular capacitance value which is quickly selected by means of an automatic binning operation it devised.

The uniformity of capacitor size within certain bin ranges was one of the reasons why molded epoxy shells were chosen. Tape-wrapped capacitors with epoxy resin end-seals had been considered, but they tended to vary in diameter and length, even though the capacity was correct. Other important considerations are that epoxy shell construction with a centering disc makes both leads concentric with OD (of much consequence to trouble-free operation of equipment); there is much greater mechanical protection; and they have excellent moisture resistance.

Polystyrene capacitors formerly were made by embedding the section in a paper tube in which the ends were sealed with wax. This was a rather expensive method, apart from other disadvantages. Although the paper was wax-impregnated, moisture leaked into the ends and through the body of the case because the wax was quite permeable and had a high coefficient of expansion. By encapsulating the section with epoxy resin in a molded epoxy shell, the leads as well as the open end of the shell are sealed completely against moisture.

According to Robert Hamilton, Lenkurt industrial engineer, this type of capacitor packaging can lend itself easily to mechanization, or even semi-automation, if volume of production warranted it.

The round shells for the polystyrene capacitors are molded in nine size ranges by Precision Plastics, Inc., San Francisco, Calif., from epoxy molding powder. There are two standard lengths, 1-inch and 1¾-inch, with diameters from ⅜-inch to ¾-inch. Shell walls are .015-inch thick and taper slightly from top to bottom. To minimize leakage of resin, the hole in the shell bottom has a .001-inch tolerance with relation to the thickness of the wire lead. The bottom of the shell is countersunk 120° in the molding operation, providing a mass of epoxy material to prevent leakage of moisture around the lead; and secondly, permitting easy entry of the lead. Thickness of the shell bottom is .062-inch. Before they are used, the molded shells are solvent-cleaned to remove dirt and other contaminants which could impair the bond of encapsulating resin to shell.

Wire leads are attached to the capacitor sections by a dip-soldering method. Sections are then brought to the encapsulation table where three workers perform the three separate steps in joining section to shell. In the first, 25 shells with open ends up are placed in an aluminum jig. This jig has a hinged drop-out feature in the bottom so that the completed capacitors can be dropped onto a wire

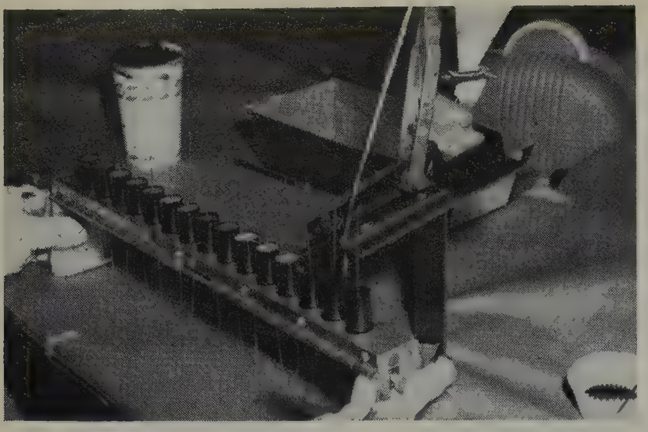


Figure 5, disc is pressed down and upper part of capacitor is filled with resin.

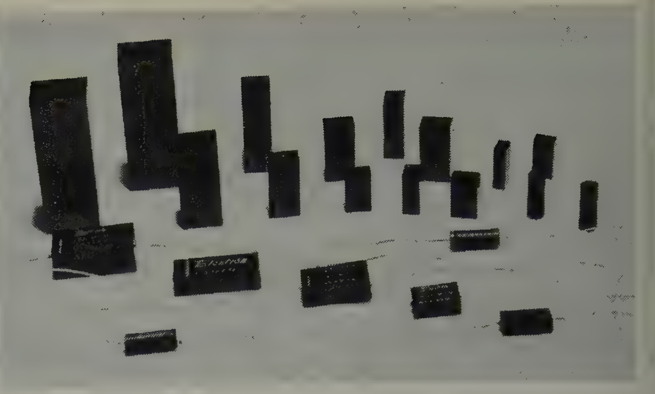


Figure 6, rectangular molded shell capacitors are made by Electron Products in a range of sizes. Shells are produced by Teksun, Inc.

screen tray without the need to remove them individually. The capacitor section is installed partially in the shell with the lead extending through the hole.

A paper disc, which is slipped over the top lead, centers the wire and also ensures filling the upper portion of the shell with a predetermined amount of resin.

Jules Palen of Lenkurt's Components Development Section specifies a two-component epoxy system to pot the capacitors. It is a filled material, somewhat thixotropic, with a pot life of nearly four hours. Resin and hardener are stored in agitated tanks before being mixed in the proper proportions and brought to the workers.

The aluminum jig is moved along to the second stage where a premeasured amount of the resin is poured into the bottom of the shells. This is done by means of a foot-operated device which squeezes the resin through a disposable polyethylene tube, gravity-fed from a paper container. One third of the shell is loaded with the resin at this time. When the wire lead is pulled down, the capacitor section is seated in the bottom of the shell and the resin is forced up the sides of the shell.

The capacitors are moved to the third stage where the paper disc is pressed down against the section before the top pour of resin is made with another dispenser. When all 25 capacitors have been encapsulated, they are transferred to the metal screen and then taken to curing racks. The resin cures in 16-24 hours at room temperature.

After they are cured, the capacitors are subjected to a controlled hot and cold temperature stabilizing cycle. This operation reduces any residual strains created by winding, lead attachment, and resin curing. Eliminating these strains results in a capacitance variable which is maintained to very close limits. The final step consists of testing the capacitors at three times the rated voltage to ensure adequate voltage protection in service.

Electron Products Method

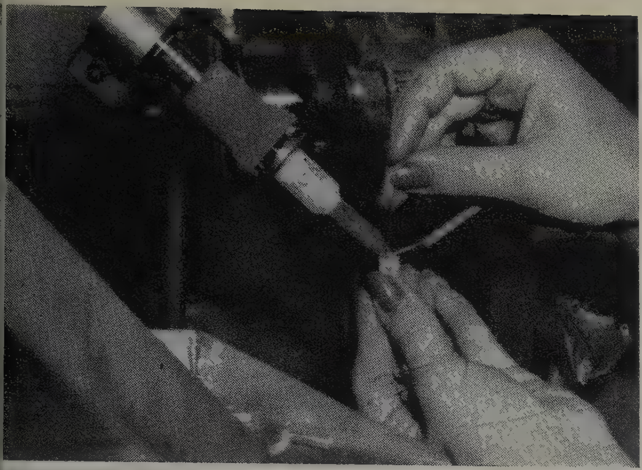
This company produces metallized "Mylar," metallized paper, and conventional capacitors, which are encapsulated in rectangular molded shells made by Teksun, Inc., Los Angeles, from epoxy molding powder. According to engineer Robert R. Dowty, Electron Products pioneered this particular shape in order to pack more capacity into a smaller unit. Rectangular shells permit pressing the capacitor windings flatter and closer together. As a result, there is less space between the dielectric material, the effective K value is increased, and greater capacitance results.

Shell-encased capacitors are relatively new products for this company. They were developed to fill the gap between their wrap-and-fill capacitors and the premium-grade hermetically sealed units. They also serve to meet the growing need for high reliability capacitors at a somewhat more economical price. The capacitors range from 3/16-inch by ¼-inch to ⅜-inch by ½-inch, with lengths varying from ⅜-inch up to 2-inch. In most cases the shells have a wall thickness of .015-inch. Electron Products investigated several methods of encapsulation but finally selected the molded shell process.

The precision capacitors are made mostly to customer specifications and fabrication therefore is rigidly controlled. After capacitors are wound, the wire leads are soldered in a conventional manner. The sections are then voltage-cleared to remove voids or defects in the paper material. The next step is impregnation of the wound section. The company feels that a solidly-impregnated capacitor ensures a higher standard of quality, particularly when it is intended for service at temperatures upwards of 125°C.

Capacitors are placed in a metal mesh basket which is set in a vacuum oven for a specified length of time to dry out the paper. From here they go into a tank where they are impregnated with a two-component resin system of low viscosity that was developed especially to withstand high vacuum processing.

At the end of the impregnating period, the wound sections are transferred to a pressure system where dry nitrogen (an inert gas to avoid possible contamination) is applied to drive the resin into any voids that may be present internally. Sections are allowed to drain to remove the excess epoxy resin from the capacitor section leads. Finally, they are placed on trays and oven-cured for approximately 24 hours. After sections are cured, they are



igure 7, leads are attached with a soldering gun. Sections re then cleared.

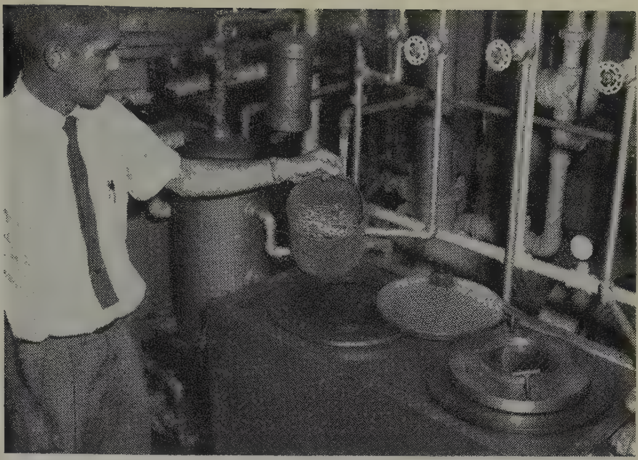


Figure 8, all wound capacitor sections are epoxy-impregnated before they are encapsulated in the epoxy shells.

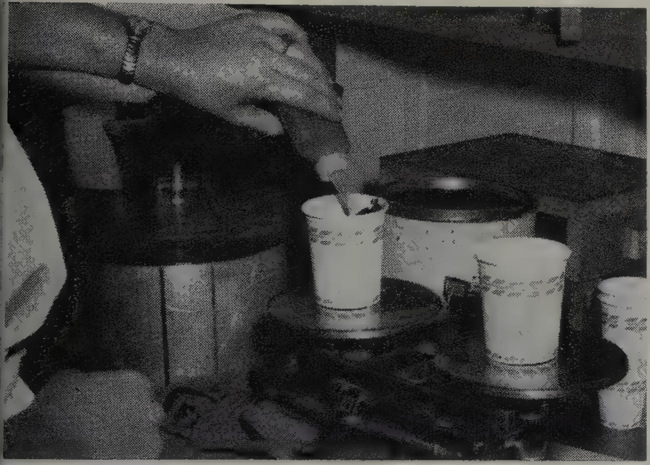


Figure 9, proper proportioning of resin and hardener is important. Mixing takes place at central station.

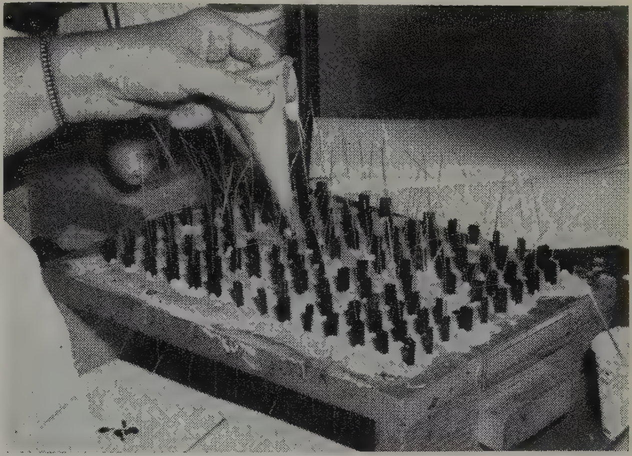


Figure 10, worker uses paper cone to dispense resin into rectangular shells.

sent through quality control for checking of dissipation factor and internal insulation resistance. They are then ready for assembly into the molded epoxy shells.

Each worker handles just one size of shell at a time. The shells are loaded into jigs coated with a parting agent. The wire lead of a capacitor section is fed into the bottom hole of the shell and placed into position.

The encapsulating epoxy resin is prepared in 40-gram lots at a central mixing station and delivered to the individual worker in kraft paper cones. The material has a 30-minute pot life but is used up quickly enough to prevent premature gelling.

Resin is poured into the shell until it is filled. After a certain amount of training and experience, the worker becomes adept at gauging the right amount. Any air bubbles on the top surface are removed by spraying the capacitor with a solvent-blend which lowers the surface tension.

Capacitors are allowed to cure for 8 to 16 hours (usually overnight) at an ambient temperature of 75°F. At the end of this time, the resin has cured sufficiently to permit testing of the units. Metallized Mylar capacitors are tested for an insulation resistance of 10,000 meg. times mfd. minimum at 25°C, a dissipation factor of less than 1.0 percent at 25°C and an operating temperature from −55°C to +85°C, and higher with derating. Metallized paper capacitors are tested for a maximum insulation resistance of 1500 meg. times mfd., a dissipation factor of less than 1.0 percent at 25°C and an operating temperature from −55°C to +125°C.

Environmental tests are carried on almost continuously. Capacitors are immersed in hot (65°C) and cold (0°C) saturated salt solutions alternately for one hour each over a 10-hour period. They also have to withstand 250 hours of 95 percent relative humidity at 40°C, plus temperature cycling.

Electron Products also manufactures special molded capacitors in limited runs, some with high voltage capacity in sizes up to 2½-inch diameter and 8-inches long. In such cases, a master mold first is made of aluminum. From this is cast a flexible mold from a vinyl chloride plastisol compound. The capacitor sections are placed in the flexible mold and epoxy resin is poured in to completely encapsulate it. After the resin has cured, the mold is stripped off. The only finishing step required is machining of the top.

Electrical Insulation Program for May 1-3 Electrochemical Meeting

The following program of technical papers has been scheduled by the Electric Insulation Division of the Electrochemical Society for its meeting at the Claypool Hotel, Indianapolis, Ind., on May 1-3. All sessions will be held in Room D-1. These papers probably will be reviewed in *Insulation* at a later date.

Monday, May 1

9:00 am—Electric Insulation Division Business Meeting, Room D-1; A. J. Sherburne, Chairman.

Thin Film Dielectrics—C. C. Houtz, Bell Telephone Laboratories, presiding.

9:30 am—Electrolytic Oxide Films, by C. C. Houtz.
10:00 am—Electrical Properties of Evaporated Aluminum Oxide Films, by E. M. DaSilva and P. White, International Business Machines Corp.
10:30 am—Charge Storage Effects in Tantalum Oxide Films, by Rudolf Dreiner, Sprague Electric Co.
11:00 am—Polarity of Tantalum Oxide Printed Capacitors, by N. Schwartz and M. Gresh, Bell Telephone Laboratories.

Thin Film Dielectrics (Continued)—R. A. Ruscetta, General Electric Co., presiding.

2:00 pm—Dielectric Properties of Evaporated Film Capacitors, by F. S. Maddocks and R. E. Thun, International Business Machines Corp.
2:30 pm—Physical and Dielectric Properties of Thin Film SiO_2 Capacitors, by J. A. Minahan, J. L. Sprague, and O. J. Wied, Sprague Electric Co.
3:00 pm—Electrical Properties of Evaporated Thin Film SiO_2 Capacitors, by D. B. York, International Business Machines Corp.
3:30 pm—Round Table, panel composed of thin film dielectric symposium speakers.

Tuesday, May 2

Epoxy Resins—L. J. Frisco, Johns Hopkins University, presiding.

9:30 am—Epoxy Resins from Fats, Monomer Structure and Resin Properties, by William S. Port, Eastern Regional Research Laboratory.
10:00 am—A Flame Retardant Epoxy Resin, by R. A. Cass, Monsanto Chemical Co.
10:30 am—The Preparation of Silicone-Epoxy Resins and Their Properties in Glass Cloth Laminates, by S. A. Brady, Dow Corning Corp.
11:00 am—Strength Retentivity of Cured Epoxy Systems in Mineral Acids, by John Delmonte, Furane Plastics Inc.

Epoxy Resins (Continued)—A. J. Sherburne, General Electric Co., presiding.

2:00 pm—The Electrical Properties of Epoxide Polymers, by R. W. Warfield and M. C. Petree, U. S. Naval Ordnance Laboratory.
2:30 pm—The Mechanical and Electrical Properties of Oxiron Resins, by C. W. Johnston and M. H. Reich, Food Machinery and Chemical Corp.
3:00 pm—The Effect of Curing Agents Types and Concentrations on the Mechanical and Electrical Properties of Epoxy Resins, by P. A. Teliha, Shell Chemical Co.
3:30 pm—The Mechanical and Electrical Properties of New U.C.P.C. Epoxy Systems, by F. L. Williamson, Union Carbide Plastics Co.

Wednesday, May 3

Epoxy Resins (Continued)—A. Gunzenhauser, Transisola Inc., presiding.

9:00 am—The Effects of Radiation on the Electrical Properties of Epoxy Resins, by J. W. Kallander, U. S. Naval Research Laboratory.
9:30 am—The Physical and Electrical Properties of Epoxy Resins as a Function of Chemical Composition, by C. L. Segal, Hughes Research Laboratories.
10:00 am—Comparative Rheological and Fracture Properties of Epoxy Resins in the Glass Transition Range, by D. H. Kaelble, Minnesota Mining and Manufacturing Co.
10:30 am—Effect of Elevated Temperature on the Physical and Electrical Properties of Epoxy Resin Bonded Glass Fabric Base Laminates, by A. H. Haroldson, Continental-Diamond Fibre Corp.
11:00 am—The Properties of Paper Based on Glass Based Copper Clad Epoxy Laminates, by H. R. Levine, General Electric Co.
11:30 am—Wire Insulation Life Determined as a Chemical Reaction Rate Function, by E. L. Brancato, U. S. Naval Research Laboratory.

Epoxy Resins (Continued)—L. L. Deer, presiding.

2:00 pm—Round Table, panel composed of epoxy symposium speakers.

SILICOLOGY *Studies in Silicones*

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

Versatile Rubber Compound Serves For Many Types of Insulation

L. Frank Markel & Sons, Norristown, Pa., has added UNION CARBIDE K-1347 Silicone Rubber Compound to the list of carefully selected materials used in the fabrication of its broad line of products, which include extruded tubings, insulated wire, and coated braid sleevings.

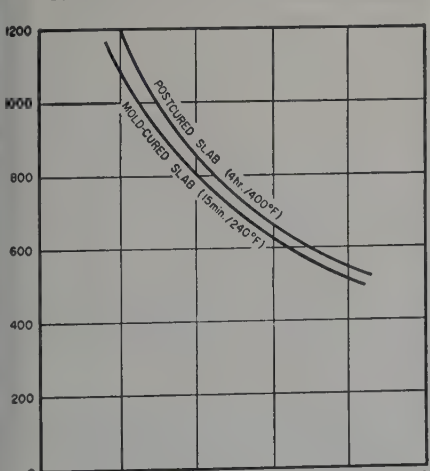
Selection of the versatile material with a combination of properties not found in any other single silicone rubber compound, followed searching discussion with the UNION CARBIDE Silicones Man of the requirements to be met.

Besides the economy of convenience, the company reports that K-1347 has enabled them to maintain their high quality standards. Customers, moreover, have reacted favorably to the physical and electrical properties of the finished material.

EXCELLENT PROCESSIBILITY

Originally developed as a premium quality compound for extruding, calendering, and molding, K-1347 in testing exhibits superior physical properties—high tensile (1400 psi after 10 minutes' molding cure at 240°F), tear, and elongation—and excellent electrical properties as well *(see graph)*.

Dielectric Strength vs. Thickness
"UNION CARBIDE" K-1347 Silicone Rubber

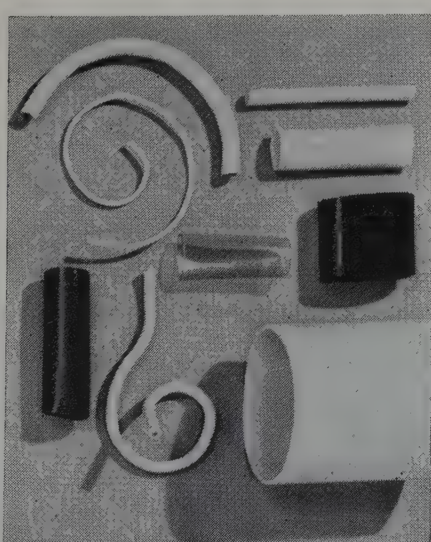


*ASTM D149-59:
Constant Rate of Rise. ¼" Electrode in 74°F. Air.

When extruded onto wire and cured in hot air or steam, K-1347 satisfies military specifications MIL-W-19381, MIL-W-8777, and MIL-W-16878 (F&FF). Shrinkage in mold-curing is less than 2.5%, in postcuring less than 3.6%. The compound is normally supplied white or clear, but it can be easily colored to desired shades.

OTHER FABRICATOR REPORTS

Another customer/fabricator, using K-1347 in "spaghetti" sleeving, is reported saying, "Physical properties are fine . . . testing of sleeving gave readings over 1100 volts per mil on 13.5 mil wall thickness . . ." A third customer recently extruded K-1347 onto 15 mil electrical tubing. Dielectric breakdown, measured via ASTM D149-59 method, was 14,900 volts compared with competitive product's 7,000 volts (approximate).



A FEW OF THE MANY quality Silicone Rubber electrical insulation products fabricated by L. Frank Markel & Sons, Norristown, Pa.

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COMPOUNDS PASS FLAME TEST

Both UNION CARBIDE Compounds K-1347 and K-1357 pass the flame test on wire called for in spec Mil W-16878. The test requires applying a Bunsen Burner flame to a sample of wire for 30 seconds. The wire is suspended in a position 45° from the horizontal. The flame is applied at the lower of two marks on the wire 6 inches apart, and length of flame travel and burning time are observed. Specification calls for a maximum of 3 inches of flame travel and 30-second burning time.

Experiment with K-1347 in your products—and be surprisingly rewarded—next time you have an appropriate application where superior physical and electrical properties are important, and where you could really save with ease of fabrication and handling. Send the coupon for further information.

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A New Polyester Dielectric for Capacitors

By Richard G. Devaney, Research Laboratories, Tennessee Eastman Co., Division of Eastman Kodak Co., Kingsport, Tenn.

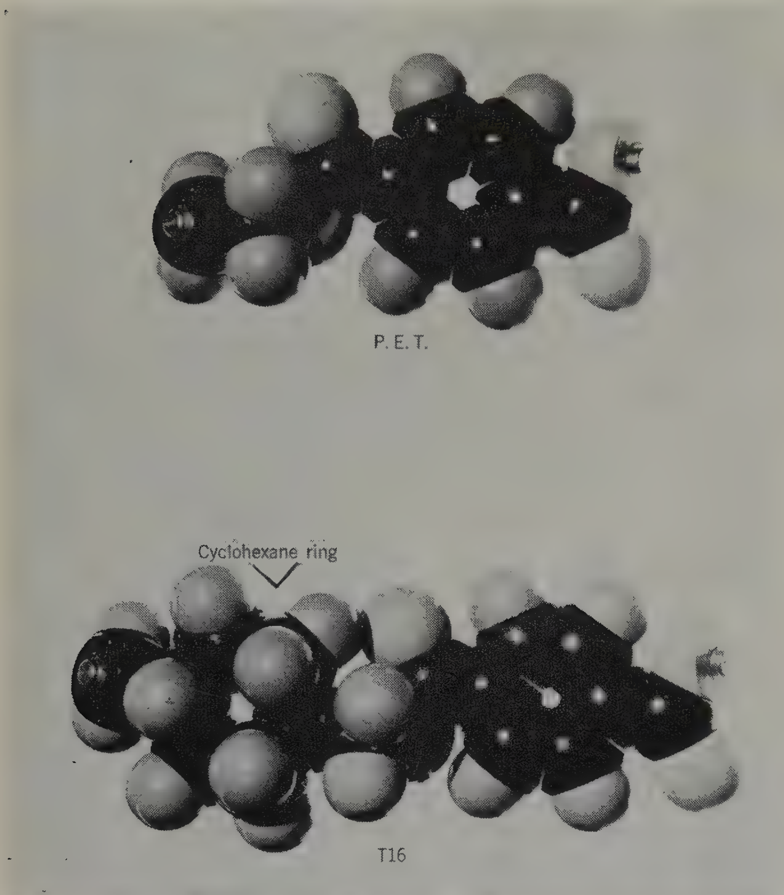


Figure 1, molecular models of T16 and P.E.T. repeating units.

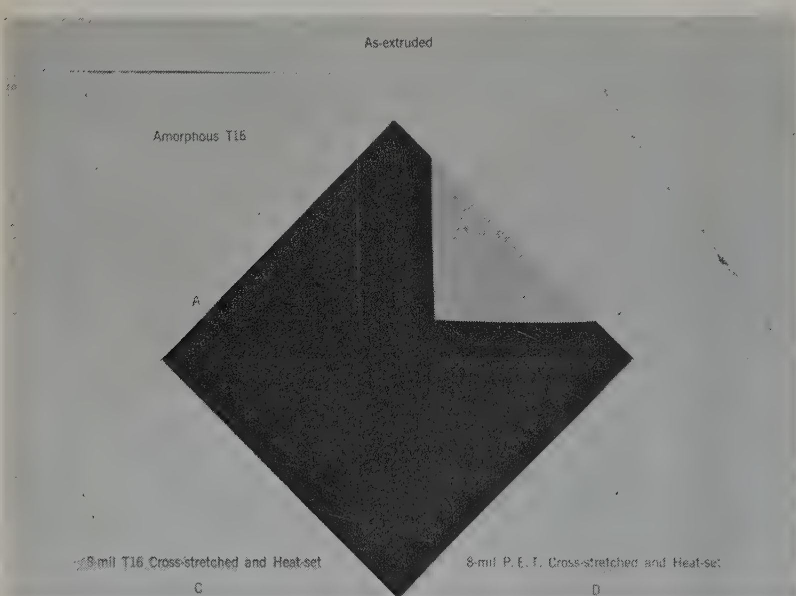


Figure 2, optical clarity of T16 and P.E.T. films. Film sample in upper righthand corner (B) is crystallized T16.

Introduction

Eastman Chemical Products, Inc., a subsidiary of Eastman Kodak Company, has announced a new polyester resin suitable for the manufacture of film. This polymer, poly(1,4-cyclohexylenedimethylene terephthalate), which is currently available as fiber, forms the basis of the new linear polyester film which is referred to in this article as T16 film.

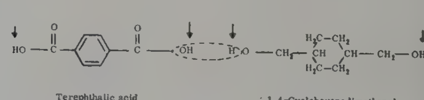
T16 film has a stable dielectric constant, low dielectric loss, high dielectric strength, and high volume resistivity. In addition, it has outstanding resistance to the deleterious effects of water vapor, solvents, and alkalies. Capacitors made from T16 film have long lives under accelerated aging conditions and have high insulation resistance. The hydrolytic stability of T16 is so outstanding that capacitors can, under many circumstances, be operated without cases.

The chemical nature of T16, its electrical and physical properties, and some of the extreme tests used in the preliminary evaluation program are described in this paper.

Chemical Structure

T16 is a linear polyester; that is, its primary chemical bonds exist in a line, or chain-like fashion, and there is no primary bonding between chains. Thus T16 is a thermoplastic polyester which will soften and flow repeatedly under the influences of heat and pressure.

T16 is made by the reaction of terephthalic acid and 1,4-cyclohexanedimethanol. In this reaction, water is split out and the repeating unit is formed.



The reaction continues until approximately 36 repeating units have joined.

The important difference between

Table 1—Physical Properties of T16 Film Property (0.5-mil film)	25°C	−50°C
Density, g./cc.	1.226	—
Refractive index	1.596	—
Yield strength, psi	10,200	15,800
Break strength, psi	18,000	22,600
Elongation at break, %	55	32
Modulus, 10^5 psi	4.0	4.8
Tear strength, g/mil	6.0	—
M.I.T. fold endurance, cycles	>60,000	—
Burst strength, psi	28	—
Moisture absorption, 24 hr at 25°C, %	0.30	—
Water vapor permeability, g-mil/100 in²/day	1.8	—
Flammability	Will not sustain flame due to melting (ASA burning rate)	—
Color	Brilliant water-white	—

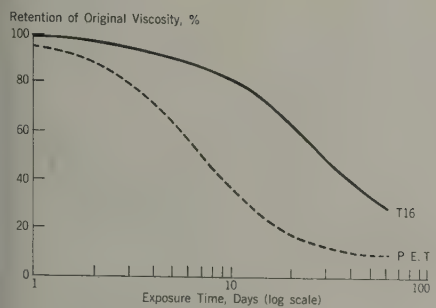
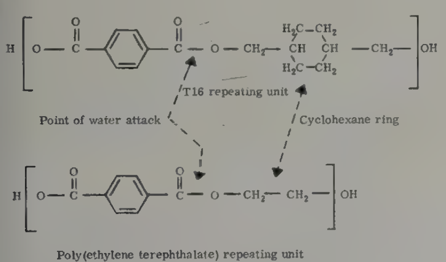


Figure 3, hydrolytic stability of polyester films at 110°C and 100% relative humidity.

T16 and poly(ethylene terephthalate) [P.E.T.] is the presence of a cyclohexane ring between the two methylene groups.



The presence of the cyclohexane ring causes several significant differences in their respective properties; for example, the melting point of T16 is higher than that of poly(ethlyene terephthalate).

The presence of this large group hinders the splitting out of water. Thus, conversely, after the polymer is formed it is extremely difficult to hydrolyze. Figure 1 is a photograph of molecular models of the P.E.T. and T16 repeating units and illustrates the relatively large size of the cyclohexane ring and the protection it provides for the C-O linking bond. This is an important asset.

T16 Film Manufacture[1]

To manufacture T16 film, pellets of the polyester are melted at about 300°C and extruded to form an amorphous sheet, as seen in figure 2A. This sheet is tough and clear, with a thickness dependent upon the ultimate film thickness desired. At this stage, the film does not have its best properties, since heating it above 90°C for some time causes crystallization to occur (2B). The film then becomes opaque, white, and brittle. Therefore, the amorphous film is usually heated and stretched lengthwise until it is two or three times its original length. This treatment causes the molecules to line up preferentially along the axis of the film. It is then stretched widthwise the same amount, inducing planar orientation and is heat-set in a restrained condition at a higher temperature to induce crystallization (2C). Figure 2D shows a sample of P.E.T. which is commercially available and which has been cross-stretched and heat-set. It is felt that the T16 film has superior optical clarity. T16 film biaxially oriented and heat-set showed less than 2% distortion at 50 psi initial stress up to 190°C. Poly(ethylene terephthalate) film shows an equivalent distortion at 170°C. T16, depending on the formulation, melts at 265 to 290°C, which is 7 to 30°C higher than poly(ethylene terephthalate) melts. It is important to note here that the processing can be terminated following any of the above steps in order to capitalize on the distinctive film properties associated with each step. Film can be made with only one-way stretch, with or without heat-setting. Such a film, for example, without heat-setting, has a tendency to shrink lengthwise upon subsequent heating. When heat-set, it has good lengthwise physical properties at the expense of the widthwise properties.

Physical Properties

T16 is not so strong or tough as poly(ethylene terephthalate) and has a somewhat lower tear strength. The magnitudes of these differences are close to those which can be calculated on theoretical grounds from the lower density of T16. The density of T16 is 12% lower than that of poly(ethylene terephthalate). Thus, in uses where the mechanical properties are not paramount, the lower density represents 12% more film per pound of resin. On the other hand, when the strength properties are of most im-

Figure 4, capacitors of T16 and P.E.T. after 8-day hydrolytic stability test.

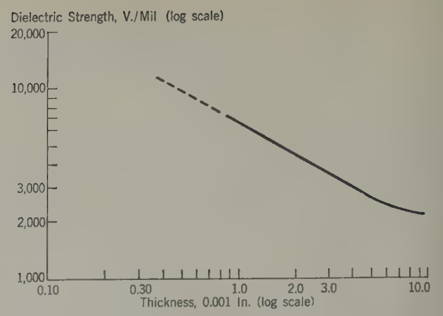


Figure 7, dielectric strength of T16 film as a function of thickness.

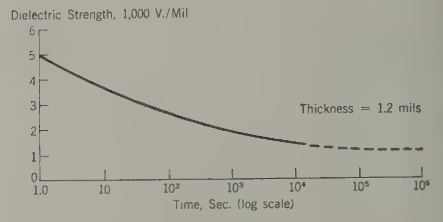


Figure 8, dielectric strength of T16 film as a function of time.

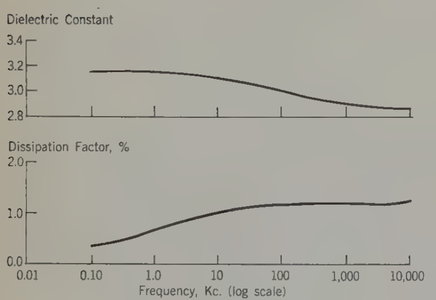


Figure 5, dielectric constant and dissipation factor of T16 film as functions of frequency.

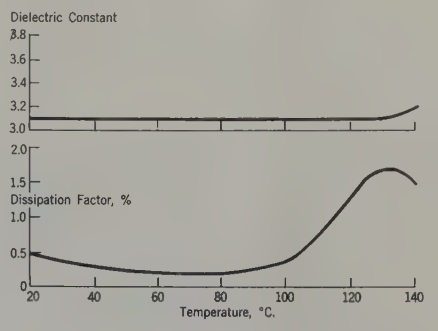


Figure 6, dielectric constant and dissipation factor of T16 film as functions of temperature.

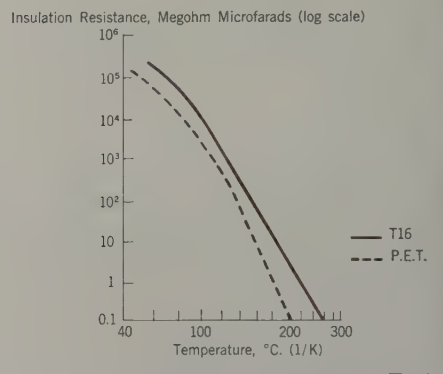


Figure 9, insulation resistance of T16 and P.E.T. films as a function of temperature.

portance, much of the difference in these properties of T16 and P.E.T. can be made up by using thicker film. T16 film was physically unaffected by 4 weeks' immersion in aromatic or aliphatic hydrocarbons, turpentine, gasoline, organic or inorganic esters. Other physical properties of the film are listed in table I.

Chemical Properties

The oxidative stability of T16 film is not quite so good as that of poly(ethylene terephthalate) film, but antioxidants can be added to raise its stability to a level which is better than that shown by poly(ethylene terephthalate) film.

The hydrolytic stability of T16 film is significantly better than that of poly(ethylene terephthalate) film. Poor hydrolytic stability is a known shortcoming of poly(ethylene terephthalate) film, but no method is presently available for improving this property substantially.

The testing procedure used to evaluate this important property involved holding the film at 110°C and 100% relative humidity for various periods of time. The effect of this exposure on film solution viscosity is shown in figure 3. Solution viscosity is a measure of molecular weight. Poly(ethylene terephthalate) degrades quite rapidly in comparison with T16. In practical terms, this means that after four or five days of such treatment, an *uncased* capacitor of poly(ethylene terephthalate) crumbles and falls apart on handling, whereas a similar T16 capacitor is unaffected either physically or electrically. As a matter of fact, the T16 film capacitors can still be handled after 21 days of such treatment. Photographs of typical *uncased* capacitors after an 8-day test are shown in figure 4.

T16 film was unaffected by 4 weeks' immersion in 10% sodium hydroxide solution.

Electrical Tests and Properties

Film made from T16 is inherently a good dielectric. With a dielectric constant of approximately 3.1, the film shows excellent stability with both temperature and frequency. The dielectric constant and dissipation factor of T16 film are shown as functions of frequency (figure 5) and as functions of temperature (figure 6). These properties were determined in accordance with ASTM D150-54T. Capacitors wound from T16 film show very little change in capacitance over the temperature range of 20 to 150°C.

The dielectric strength of T16 is excellent. A typical value is 9000 v/mil at 60 cycles and 500 v/sec for 0.5-mil film. Figure 7 illustrates the dielectric strength as a function of thickness for instantaneous breakdown and figure 8 shows the dielectric strength as a function of time for 1.0-mil film. Because of fundamental characteristics of the chemical structure, the improved dielectric strength is apparent over a wide temperature range and is especially apparent at elevated temperatures.

The insulation resistance of unimpregnated T16 film capacitors, compared with similar units constructed from poly(ethylene terephthalate), is shown in figure 9. The tests were conducted on 1.0-μf capacitors wound from single-layer, 0.25-mil film. The capacitors were electrified at 90 v for 5 minutes. In these tests, T16 film excelled at every temperature and differences between the films increased with increasing temperature.

Capacitors

Much of our electrical evaluation of T16 film was centered on its use as a capacitor dielectric. Special regimens and equipment were devised to conduct accelerated aging tests and to make comparisons with other dielectrics, particularly, poly(ethylene terephthalate).

Capacitors were manufactured on a Kroessler semiautomatic capacitor winder, usually using an extended dielectric and wire leads. At the time of winding, the capacitors were subjected to a 24-v, 60-cycle flash test. When all of the capacitors were made, they were then flashed at 1000 v d-c. The capacitance was then checked on a 10% random sample. (The capacitance is also a check on the gage of the film). Following a suitable treatment, groups of 10 capacitors were subjected to the accelerated aging tests. In this test the capacitors were subjected to unusually high temperatures and voltages and the time dis-

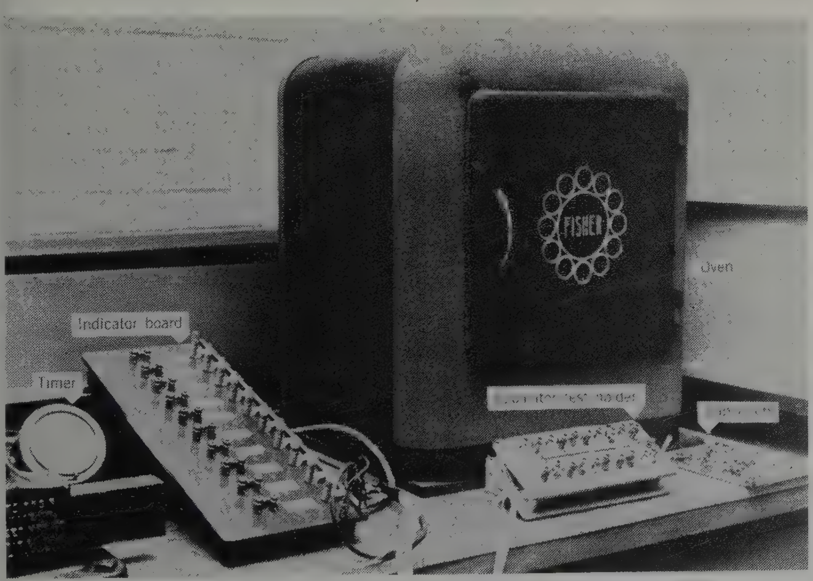


Figure 10, apparatus for accelerated aging of capacitors.

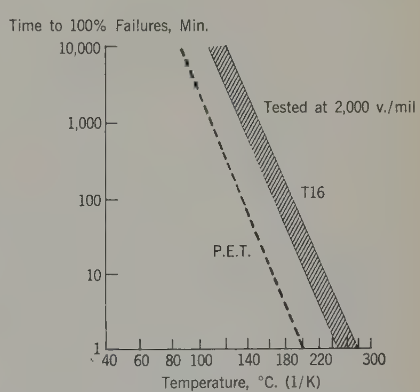


Figure 13, results of accelerated aging tests on capacitors made from T16 and P.E.T. films.

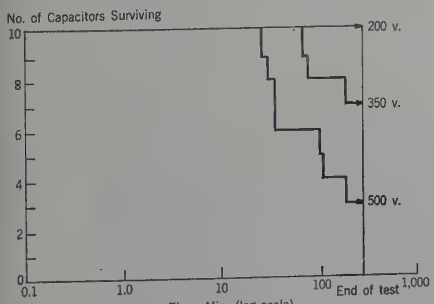


Figure 11, T16 capacitor performance during accelerated aging tests.

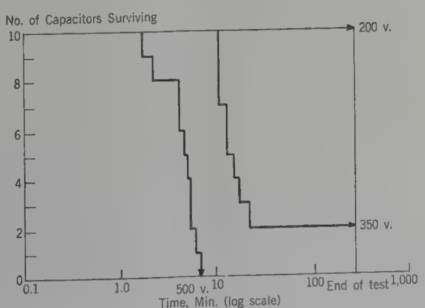


Figure 12, P.E.T. capacitor performance during accelerated aging tests.

tribution of failures was determined. The temperatures employed were: 140, 155, 170 and 185°C. The voltage stresses used for 0.25-mil film were 800, 1400, and 2000 v/mil. The apparatus for this testing, shown in figure 10, consisted of two main parts. On the left is the signal board, a network of resistors, and neon lights, to indicate when each capacitor fails. On the right is the sample holder, electrically connected to the signal board by means of a cable. The sample holder is mechanically separate in order that it can be made of high-temperature resistant materials, that is, asbestos-cement board and polytetrafluoroethylene.

For testing, the 10-capacitor sample holder was placed in the preset oven (extreme right). After allowing 5 minutes to attain temperature equilibrium, the preset voltage was abruptly applied. The datum recorded was the time required for each capacitor to fail, as illustrated in figure 11 (0.25-mil T16 at 170°C) and figure 12 [0.25-mil poly(ethylene terephthalate) at 170°C]. The results of many such tests are summarized in figure 13[2], where the longevity vs. temperature is shown for T16 and poly(ethylene terephthalate).

Because of the outstanding chemical and electrical properties, and considering that much of a capacitor's cost lies in the casing operation, an attempt was made to determine if uncased T16 capacitors were capable of usual operation. *Uncased* capacitors were subjected to the hydrolytic stability test. The results are shown in figure 4. The dielectric properties (figure 14) showed that T16 was unaffected, whereas poly(ethylene terephthalate) was no longer usable. Many commercial (cased) capacitors also failed this test.

Finally, uncased T16 capacitors were made for use in regular articles of commerce. All applicable capacitors in a commercial TV set, two octaves of an electric organ, two radios, an intercom, and some industrial controllers were replaced with uncased, unimpregnated T16 capacitors. The TV set is programmed to run 9 hours/day. The electric organ has been running 24 hours/day. The radios are in intermittent domestic service. The controllers and intercom are in intermittent industrial service. After almost 2 years of service, no failures or defects in operation have occurred. The underside of the TV set is shown in figure 15. These results were so encouraging that 100 1.0-μf units are now being installed in a special computer.

Summary

T16 film presents to the electrical designer a new dielectric with excellent properties. The film has adequate physical properties, excellent dielectric properties, high dielectric strength, high insulation resistance, and outstanding resistance to the deleterious effects of water vapor, solvents, *and* alkalies. Its life under accelerated aging and/or stress conditions and its chemical stability warrant consideration of T16 film for uncased capacitor operation.

References

1. For a comprehensive discussion of manufacturing and physical testing techniques, the reader is referred to "Properties of Thin Films of Poly (1,4-cyclohexylene-dimethylene terephthalate)", paper presented by M. T. Watson at the 17th Annual Technical Conference of the Society of Plastics Engineers, Washington, D.C., January 24-27, 1961.
2. Insulation aging is an inverse function of the absolute temperature and generally can be considered a chemical rate phenomenon. When the thermal life of a dielectric fits this concept, the data will form a straight line when plotted as log t vs. $1/T_{°K}$. This is conveniently done on graph paper such as K and E No. 358-26.

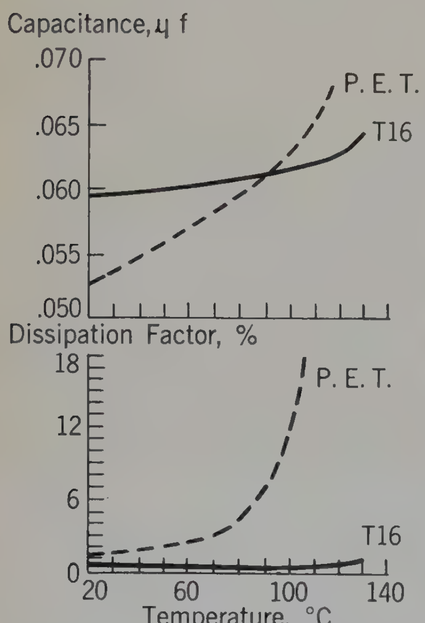


Figure 14, 100-cycle dissipation factor and capacitance of capacitors made from T16 and P.E.T. films after 8 days at 110°C and 100% relative humidity.

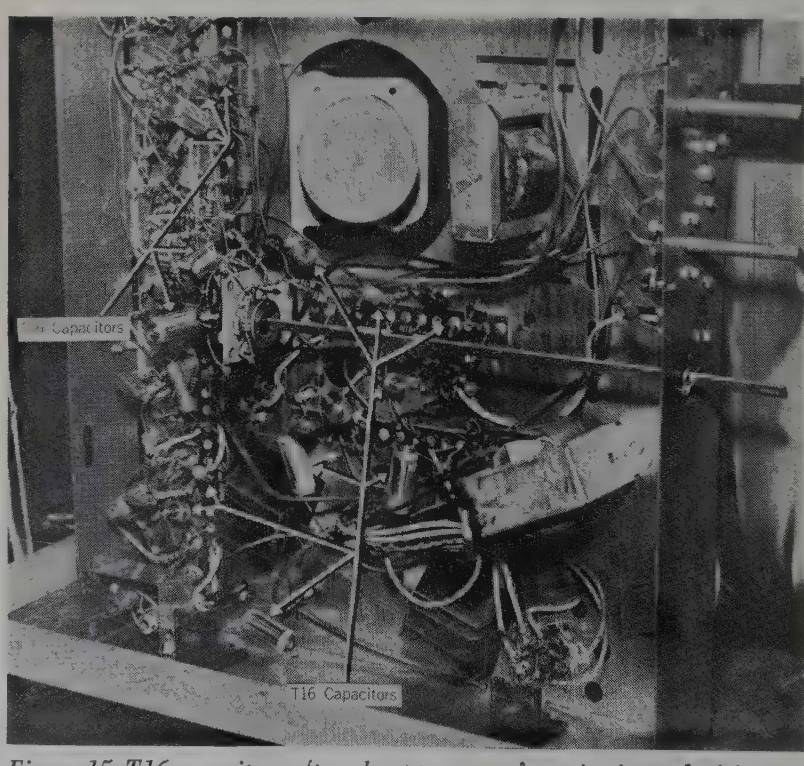


Figure 15, T16 capacitors after about two years' service in a television set.

News about R&A SINCE 1913 **Adhesives**

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Since all three feature excellent mechanical strength plus resistance to many solvents, to water, atmospheric conditions, and temperature changes, they are also widely used as insulating varnishes for impregnating coils and small electrical equipment.

•

TYPICAL PRODUCTION METHODS

Most companies develop their own techniques to bond stack laminates most efficiently. The three most commonly used are:

1) Coat, stamp, and stack;
2) Stamp, pre-coat, then stack;
3) Coil or stack, then vacuum impregnate.

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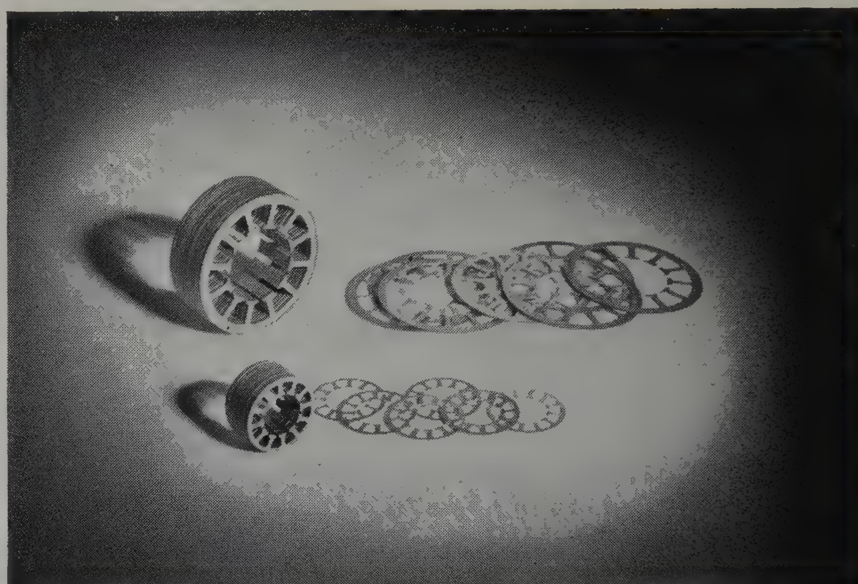

Now you can machine adhesive-bonded stack laminations of magnetic steel cores . . . machine them to tolerances as critical as you can control your equipment . . . *without fear of failures.* In addition, these laminations can now be produced without the internal stresses that have plagued the industry for so many years . . . can be made far more accurately, more uniformly, more swiftly than has ever been possible with riveted assemblies.

The "chemical fastening" of cores with BONDMASTER Series "E" adhesives is today's standard production technique in the manufacture of stators, rotors, pancake synchros, dry transformers, gyros, and servomechanisms as well as magnetic amplifiers, magnetrons, and cyclotrons.

With these solvent-dispersed thermosetting epoxy adhesive formulations, bonding is achieved by heat, alone. The only pressure you need is that required to keep the coated surfaces in complete and intimate contact during the cure cycle—a simple jig will do the job!

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These extremely free-flowing, low viscosity (some go down to less than 200 cps) adhesives can be applied by brushing, roller coating, spraying, or dipping. Coated parts may be stored before curing for periods of up to six months, if desired. Stack laminating techniques can be adapted to *your* production set-up . . . see descriptions in column at far left.

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Write for Technical Data Sheets detailing adhesive laydown, curing cycles, bonding methods, etc., of BONDMASTER Series "E" adhesives for the electrical industry.

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New Developments in Epoxy Resins

Part 5 — The Chemistry of Modern Magnet Wire Insulation

By Dr. Henry Lee, Technical Director, and Kris Neville, Project Engineer, The Epoxylite Corp., South El Monte, Calif.

The previous four articles of this series have discussed the chemical structure of epoxy resins, the chemical structure of their curing agents, formulation principles of electrical-grade epoxy resins, and new molds for low cost application of epoxy resins.

This article discusses another aspect of the proper formulation of epoxy resins for electrical applications. It discusses the magnet wire insulating resin with which the epoxy encapsulating resin must come in contact when impregnating or encapsulating coils and windings. The epoxy resin must wet and bond to such wire insulations and must serve side-by-side with it through 10 to 30 years of duty in an industrial application or through the 100 hours duty of a missile or weapons application. Hence, the chemistry of these wire enamels is important to the successful application of epoxy resins because of mechanical, chemical, and thermal compatibility considerations.

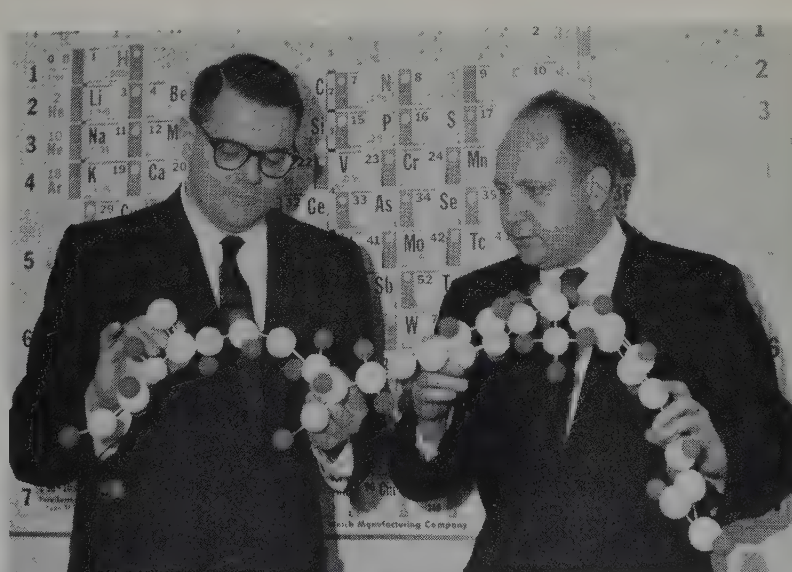
Modern magnet wires represent a great technological advance, but because they have evolved steadily, decade by decade, with little fanfare outside of specialized technical circles, it is easy to overlook the stringent requirements which magnet wires meet daily.

The properties which magnet wire must possess, by virtue of the .001 to .003 of an inch of resinous coating of insulation applied over the conductor, are really quite amazing. The coating must be flexible or supple so that the conductor can be rolled, unrolled, wound into circles or rectangles, pulled in squares, diamonds, and hexagons, pounded, formed, and otherwise mechanically abused. The coating must resist moisture, acid, alkali, solvents, and continued electrical stresses. It must resist continuous high operating temperature, temperatures to which organic materials are not normally exposed to in nature for many years. And at these operating temperatures, despite the admonition that the coating must be flexible so as to absorb the many physical abuses, the coating must not exhibit plastic flow or creep or cut-through tendencies under mechanical stresses at pressure points.

As discussed in the previous articles, there exists a principle of mutually exclusive properties, which when stated, says: there are some properties which are mutually exclusive, to attain one means to sacrifice another. In other words, to design a material to meet one property requirement may mean a severe reduction in another property. To achieve the second requirement usually means a sacrifice in the first property. Hence, the resin chemist must search for materials with molecular configurations which are better, in regard to both properties than those for other materials. Then he must make a compromise or balance of molecular weights, functionality, crosslinking density, etc., within the selected class of materials so as to achieve the best engineering compromise.

Modern magnet wire insulating resins are thus products of molecular structure engineering of a type and kind discussed in the previous articles of this series. However, numerous of the concepts must be viewed in a different light, since the ideas of chain length, functionality, crosslinking density, chemical resistance, heat stability, etc., take on a new perspective when one is dealing with a .002-

Dielectric testing of oven-aged twisted pairs checks out compatibility of epoxy resin and wire enamel.



Authors Lee and Neville examining atom model of epoxy resin and curing agent used in epoxy magnet wire enamel.

inch film, exposed to oxygen, heat, chemicals, 180 degree bends, etc. as compared to an ⅛ inch thick, relatively rigid casting, of which only the surface is exposed to the full extremes of the environment.

Many Wire Enamel Types

There are many different types of magnet wire enamels. These are, chiefly: plain enamel, "Formvar," nylon, epoxy, acrylic, polyester, silicone, "Teflon," urethane, "ML," etc. to use common chemical names of the trade. There are many, many more when all the commercial sources and their many tradenames are specified, and when special combinations such as "Formvar"-urethane mixtures, nylon-over "Formvar," and other double systems are considered.

Many electrical engineers question the value of so many types. But it is because of the very great complexity of the application requirements established by the electrical engineers themselves, the production engineers, and the end users that we find the industry presented with so many magnet wire coatings. Each of these materials is or was intended to do a certain job, to meet certain needs, and at a certain price. It may seem confusing to the user to have so many types of wire, but the pressures of technological demands and of the need to meet many different types of application must assume the blame for the introduction of so many types. It is for the same reason that we find large staffs of electrical engineers — or large computers — designing and redesigning a-c motors over and over every day — just to meet changing customer requirements. Such is also the situation with the magnet wire chemist.

If it is any consolation to the engineer who is beset with too many wire types, let us point out that the previous simple listing of wire types is but a small part of the problem facing the magnet wire chemist. The user sees the simple listing of the chemical types of wire enamel. The magnet wire chemist knows that within the general name of each type there are many types and classes which vary in molecular weight, structure, cross-linking density, curing agents, steric hindrance, tendency to form complexes with copper, oxidation equilibria, etc. Thus, the problems of magnet wire formation are not simple or cheaply solved. If there were not the demand for new products or better products, then there would be few wire types and few research problems. However, such is not the case, and the electrical engineer must take the time to learn the generalities of the many types, as electrical insulation continues to play an increasingly important role in electrical engineering.

Chemical Structure of Wire Enamels

The general chemical structure of a number of commercial magnet wire

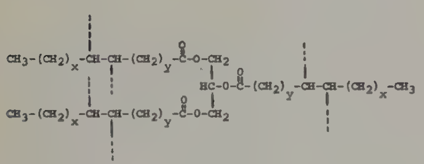


Figure 1, idealized chemical structure of "plain enamel" magnet wire insulation.

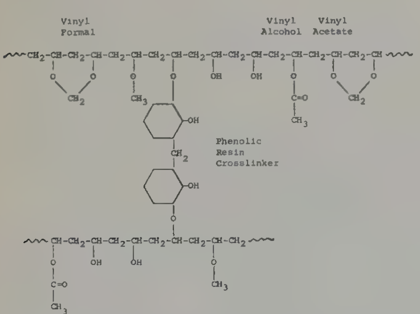


Figure 2, idealized chemical structure Formvar wire enamel (polyvinyl formal crosslinked with phenolic resin).

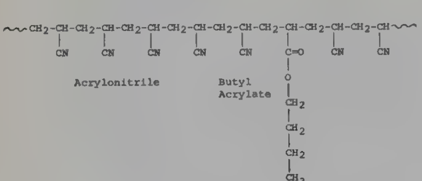


Figure 3, idealized chemical structure of acrylic wire enamel (copolymer of acrylonitrile and butyl acrylate).

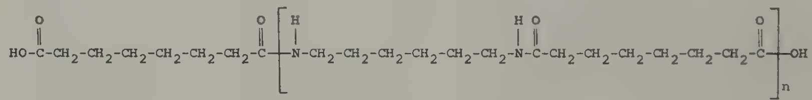


Figure 4, idealized chemical structure of nylon wire enamel (polyhexamethylene adipamide).

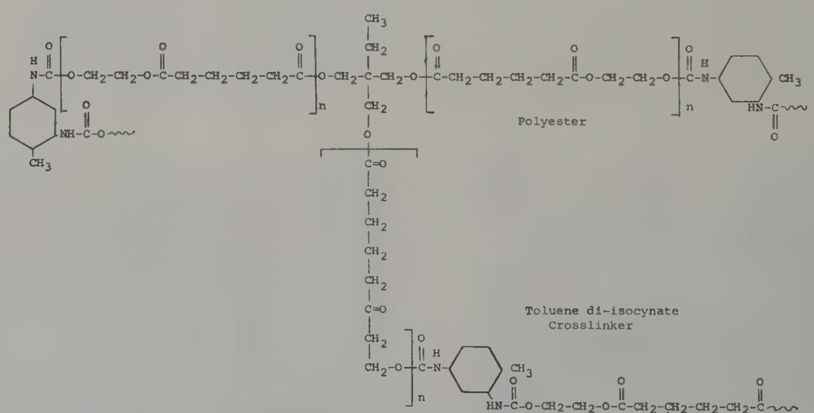


Figure 5, idealized chemical structure urethane wire enamel (polyester of adipic acid and ethylene glycol initiated on trimethylolpropane, crosslinked with toluene di-isocyanate).

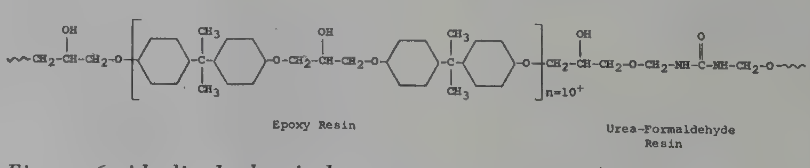


Figure 6, idealized chemical structure epoxy-urea formaldehyde wire enamel (epichlorohydrin-bisphenol epoxy and urea-formaldehyde resins).

nsulations or enamels are presented n figures 1-8. Magnet wire enamels, s manufactured, consist of solutions f the uncured resins in solvents. The namel is applied to the wire in coat- ng machines and the solvents are lriven out and the resins cured in igh temperature ovens. An infrared ile of several uncured magnet wire namels is presented in figures 9-12. An infrared file of cured enamels on copper measured by reflectance meth- ods was presented previously in this oublication (Ref. 1).

Examination of the structures in figures 1-8 reveals some of the char- acteristics of the resulting films. For example, plain enamel (figure 1), with its long aliphatic chains and ow degree of crosslinking, would be expected to have limited heat stabil- ty, limited cut-through resistance, and poor solvent resistance.

"Formvar" (figure 2) also has a ong aliphatic chain and would be expected to resemble enamel, except hat it has a longer, more positively uniform chain which adds toughness. The pendant hydroxyl groups and ace- ate groups change its intermolecular bonding (and hence solvent resist- ance, i.e., particularly to "Freons"), and the ability to adjust the crosslink- ng with phenolic groups permits control of its flow and rigidity, and has contributed to make Formvar one of the industrial standards since its ntroduction two and one half decades ago.

Polymerized acrylonitrile (figure 3) is a very inert, heat stable resin, rimarily because of its very long, egular molecular backbone and the igh electronegativity of the pendant CN groups. The introduction of a ercentage of butyl acrylate in its olymerization alters the solubility nd handling properties, but general- y the coating is applied from an queous emulsion so as to permit use f the highest chemical resistance rade feasible. The great chemical nertness of polyacrylonitrile has led o its use in special chemical situa- ions and for refrigeration motors.

Nylon (figure 4) also has a long, ontrolled chain, but because of its articular constitution, its physical roperties are manifestly different than the others above. It has good toughness, but most of all an amazing slipperiness or lubricity, which makes it preferred for many winding situa- tions. It does have a sharp softening point which limits it on overloads, and nylon directly over copper ex- hibits relatively poor moisture re- sistance. However, combinations of nylon-over-Formvar are proving very popular, since the cut-through re- sistance of this combination is out- standing. Nylon, as an aliphatic amide, is contrasted below with aro- matic amides.

Urethane wire coatings consist of hydroxyl-terminated long chain ali- phatic polyesters which are cross- linked by di-isocyanates (figure 5). The urethane linkage $\text{—O—}\overset{\text{O}}{\overset{\|}{\text{C}}}\text{—}\overset{\text{H}}{\text{N}}\text{—}$ present in these decomposes to gas readily at high temperatures and leads to the excellent solderability fea- ture of the wire.

Epoxy magnet wire films of two types are shown in figures 6-7. The epoxy-urea formaldehyde resin based type (figure 6) has been the more common type. The epoxy-polyester type (figure 7) has not been pro- moted as actively. Both contain the aromatic backbone of the epoxy resin, which gives them greater heat stabil- ity than most structures not contain- ing the aromatic backbone, but their heat stability is limited theoretically

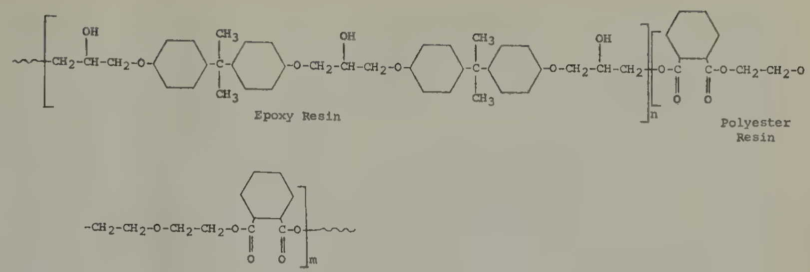


Figure 7, idealized chemical structure epoxy-polyester magnet wire enamel (epichlorohydrin-bisphenol epoxy and polyester of triethylene glycol and endomethylene tetrahydro phthalic anhydride).

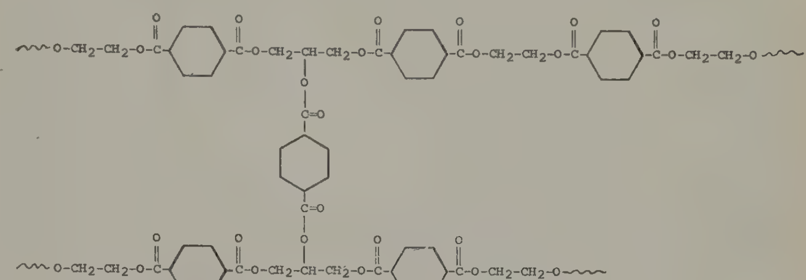


Figure 8, idealized chemical structure polyester magnet wire enamel (polyethylene glycol/glycerol terphthalate).

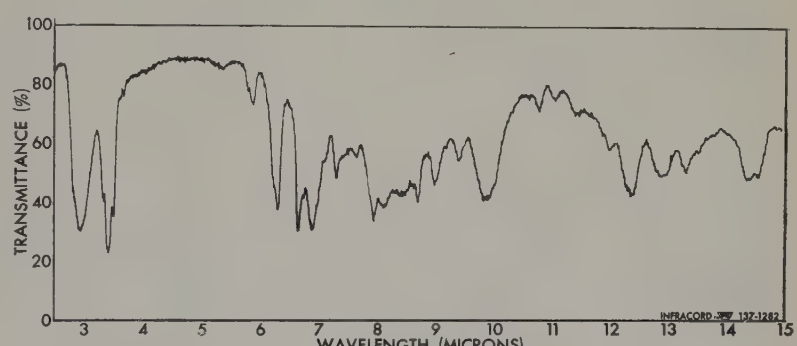


Figure 9, infrared spectrum of uncured Formvar wire enamel.

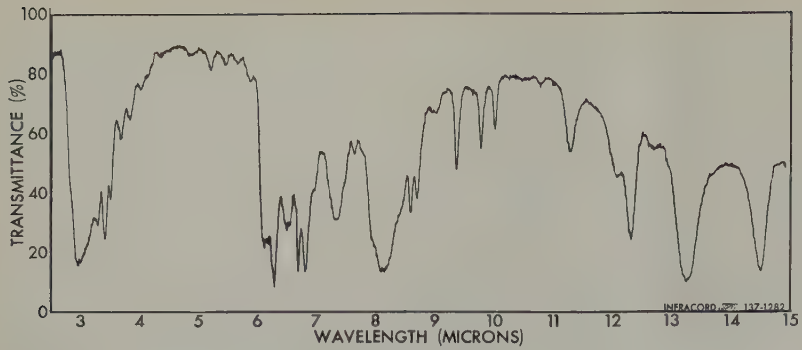


Figure 10, infrared spectrum of uncured nylon wire enamel.

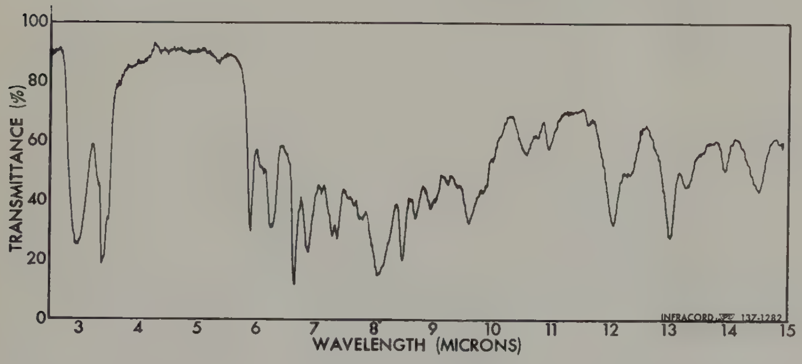


Figure 11, infrared spectrum of uncured epoxy-urea formaldehyde wire enamel.

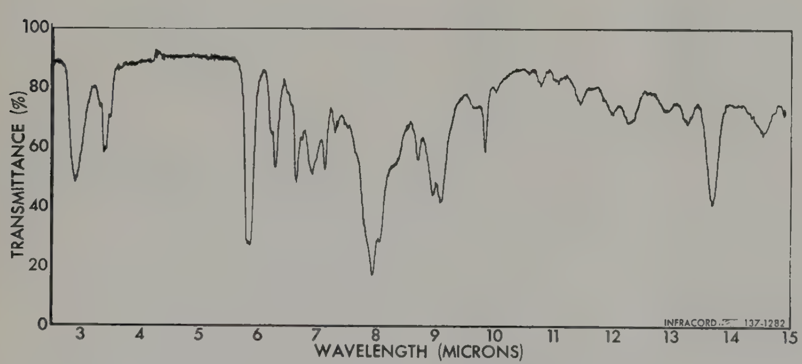


Figure 12, infrared spectrum of polyester wire enamel.

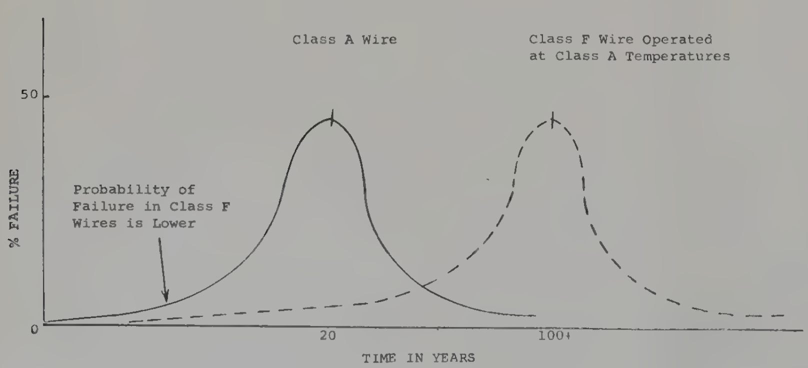


Figure 13, mathematical representation of improved reliability inherent in new high temperature wires used at class A temperatures. Assuming same shape life-probability distribution curve, but higher average life, implies greater reliability to class F wires.

to class B by bond energies of the ether links along the chain as well as the ether links formed by curing with hydroxyl terminated urea-formaldehyde resins; or, in the case of carboxyl terminated polyesters, the hydroxyl group formed in the "beta" position when curing epoxy resins with carboxylic groups provides a site for oxidation incidence, leading to chain scission and degradation. The particular chemical resistance of epoxy urea-formaldehyde wire enamels has made them very popular in oil filled transformers. The good all around properties of epoxy wires have made them popular for epoxy encapsulation systems, but the increased cut-through resistance of new polyester wires has started to give them competition.

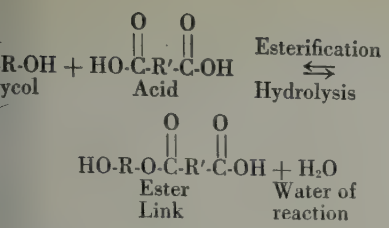
The polyester wires, which are being offered for high temperature service (class F) as well as an "extra value" in class A and B units, resemble the epoxy resin chain, insofar as they have an aromatic backbone, but the internal and crosslinking ether linkages have been replaced with the more heat stable ester groups; crosslinking is also controlled more readily by the introduction of controlled amounts of glycerol, to provide a trifunctional base in places. Thus, relatively few hydroxyl groups exist in the cured polymer, compared to the rather high percentage existant in an epoxy or Formvar chain.

Of course, the dense, compact nature of the polyesters did create initially problems of heat shock which has been improved by newer formulations and the application of a linear polyester over a highly crosslinked polyester. Similarly, the introduction of the ester linkage in place of the ether linkage, for example, has resulted in reduction of moisture resistance. Ether linkages are very moisture resistant. Ester linkages are less resistant. The phenomenon is referred to as hydrolysis.

Hydrolysis

Briefly, hydrolysis is the reverse of the esterification reaction.

In the manufacture of polyesters, the water of reaction is distilled off of the product as shown at the right



d side of the equation. In certain ditions of moisture and heat or trical stresses, the moisture introed permits the ester bond to revert hydrolyze to the glycol and acid n which the polyester was made. ntinued rupture of the ester links eventually can degrade the poly-r. However, since the initial propes of polyester wires are so exent, and since the conditions necesy for hydrolysis, which in practice m to include a completely closed l sealed system as well as moisture l heat, are so seldom encountered, s seldom that hydrolysis degrada-n effects become detectible. Thus, h type material has its advantages l disadvantages, and the excellent t stability and solvent resistance the polyesters are assuring them an expanding position in the market place.

Compatibility

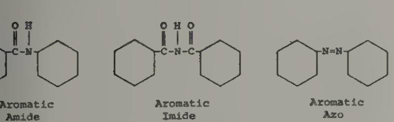
With so many types of magnet wires available, it is no wonder that when one then considers the equally numerous types of epoxy resin-curing agent systems available, that the problem of compatibility arises when encapsulating windings. Indeed, numerous epoxy resins and curing agents are excellent chemical strippers for magnet wire films. In other cases, prolonged interaction of even cured epoxy resins proves detrimental to the wire by chemical mechanisms resembling hydrolysis. In still other cases, what must be termed "differences in elastic moduli" between a rigid film and a soft potting resin, or vice versa, appear to cause rupture or cracking during thermal cycling, leading to shorted turns in electrical windings. On the other hand, certain epoxy resin systems will reinforce some wires, will heal crazing, and will upgrade some wires to a thermal life a full class above that experienced with the varnished wire in air. (See figure 14 in article 3 of this series.) The problem of compatibility is of such a specific nature that the user must rely on the recommendations of his epoxy resin or wire supplier, or do extensive testing (Ref. 2 and 3).

Why High Temperature Wires?

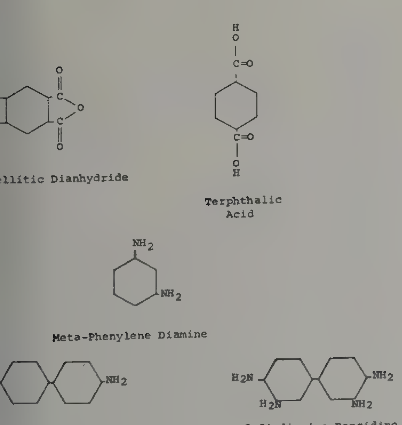
A great deal of publicity about polyester wires has stressed their high temperature service life. But it may be asked, why is so much emphasis being placed on high temperature wires, when most motors are class A (105°C hot-spot) and class B (130° C hot-spot), and when operating efficiencies of the copper and steel of motors and transformers are markedly lower at class F (155°C hot-spot) and class H (180°C hot-spot) temperatures.

There are a number of engineering and economic reasons for this trend to high temperature wires.

1. *Units for High Temperature Ambients.* There is a definite need for



ure 14, schematic of chemical ıds in aromatic amides, imides, and compounds.



ure 15, raw materials for 250°C gnet wire enamel? These chemis could well be the raw materials wires good for continuous duty 250°C.

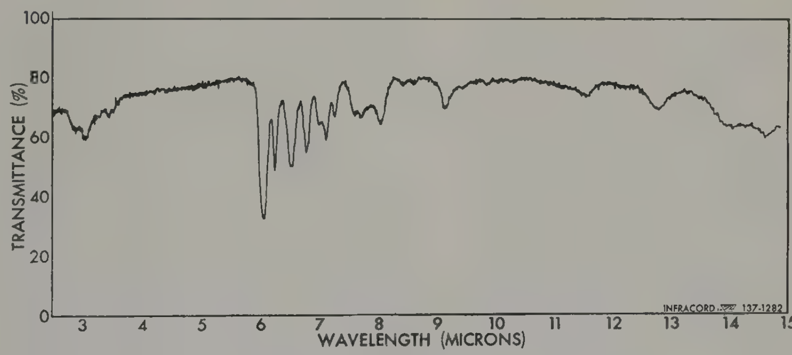


Figure 16, infrared spectrum of aromatic amide varnish.

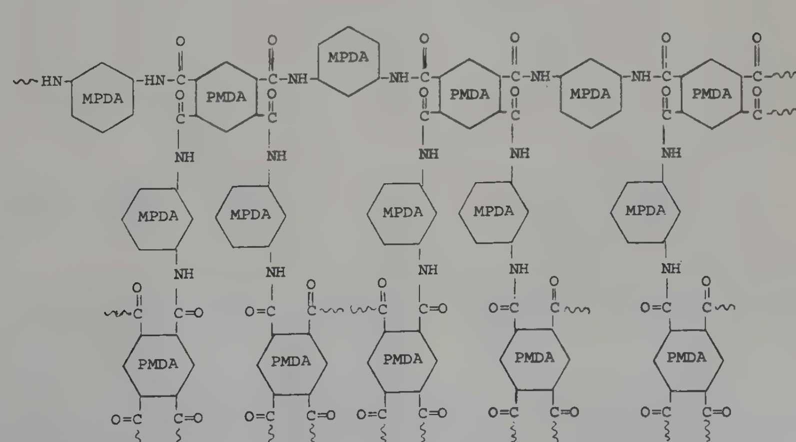


Figure 17, idealized chemical structure of an aromatic polyamide wire enamel for 200-250°C service. (Pyromellitic dianhydride and meta-phenylene diamine).

units which can operate safely and reliably in very high ambient temperatures. These units are generally located in missiles or military aircraft and fantastic temperature problems do exist.

2. *Light Weight Units.* Similarly, since units designed for operation with a 60-100°C temperature rise over ambient can be made considerably smaller and lighter, the aircraft and missile designer is often willing to sacrifice some loss in efficiency if he can save weight and space.

3. *Low Cost Units.* A smaller unit uses less iron and less copper, hence it should cost less to manufacture. With rising costs of such materials, manufacturers must turn in the direction of minimizing materials. Of course, on the industrial scene, the sales price of the class F motor, for example, must be enough less than the sales price of a class A motor to offset the extra power losses and costs of operating the class F motor over the life period to warrant its purchase. However, for many intermittent duty applications, this is easy to justify.

4. *Improved Reliability.* Perhaps one of the biggest driving forces inherent in the strive toward wires capable of withstanding higher operating temperatures is reliability. To put it another way: if a class F wire has an average life of 20 years at 155°C, then if it is operated at 105° C, it should have an average life of 360 years. Of course, such a motor would perhaps be outdated in the course of time, but statistically, what such a service life means is that the fraction or percent of units which fail before the average life of a Class A enamel is significantly reduced. This concept is sketched in figure 13.

In other words, because the average service life of a class F wire operated at class A temperatures is so great, there is less probability of an electrical failure of the wire in the first 10 years, say, than for a class A wire, as long as the wire is not mishandled during winding or exposed to adverse chemical environments.

As an indirect consequence of the striving for more heat stable, synthetic polymers, we are also achieving wires which have higher average dielectric breakdown strength at elevated temperatures. The wire enamels are more homogeneous and free of unattached radicals and unreacted species; hence, the wires are developing a higher percentage of the absolute or theoretical breakdown strength of enamel than older coatings have achieved.

Random Wind and Encapsulate 3000 Volt Machines?

One direct consequence of the improved heat stability of new wires, of their higher dielectric strength at temperature, and of their improved cut-through resistance is the growing tendency to random wind larger and larger motors (a-c stators particularly) and to do this for higher and higher voltages, up to 3000 volts. Combining such systems with epoxy resin encapsulation provides low cost units with maximum environmental protection and with heavy duty magnet wire reinforced and cushioned by epoxy resin.

Random-wound, encapsulated stators rated at 500 hp/2300 volts/class A have been in the field for over four years, and units of up to 700 hp/ 440 volts/90°C rise have been in the field for over two years.

These have generally been rewinds of older form coil windings which had failed due to salt spray or vibration, and for which no adequate protection except encapsulation was available. (Special techniques have been developed to handle split core designs.) The results are so impressive that factory designs based on this concept are now in work. In such cases, the partially closed slot of the random wound designs permits a smaller air gap and hence provides improved power factor and efficiency as compared to open slot designs.

New Class C Wires?

With the missile industry demanding higher and higher temperatures in their adhesives, coatings, and wire insulations, it follows that considerable research is going on to develop systems capable of class C (220°C) duty and higher. Fluorinated polymers such as "Teflon" and "Kel-F" are suitable in some instances, b generally have not found wide us due to difficulties of applying thi films to wire. Nor have silicone cracked this field as they tend t cyclize at these higher temperature Instead, the magnet wire researc chemists seem to be looking at a new type resin, that of aromatic amide imides, and azo compounds, who bonds possess even greater heat sta bility than the polyesters. The stru ture of these bonds is shown in figur 14. Typical raw materials for manu facturing aromatic amides, etc. ar shown in figure 15. A typical infrare spectrum is shown in figure 16. I figure 17, a hypothetical aromati polyamide such as the new ML wir enamel is shown. These materials ap pear to be satisfactory for operation in the 200-250°C range.

Commercial ML wire, encapsulate in high temperature epoxy resins has already passed the 1500 hr/210° C mark with no failure (AIEE twiste pair, 18 AWG wire, encapsulated 1000 volt check), thus extending th advantages of encapsulation into thi temperature range for numerous mis sile applications.

Conclusion

All in all, the magnet wire industr is in a state of growing technica complexity, just as is the field o epoxy resins, and the user must ex pect to have to delve deeper into th technical aspects of insulation engi neering, and must turn to more re search-minded, aggressive supplier if his products are to remain in th forefront.

Acknowledgments

The authors wish to acknowledg the assistance and cooperation o numerous individuals of Anacond Wire & Cable Co., Essex Wire Corp and Phelps Dodge Copper Product Corp. in the preparation of thi article.

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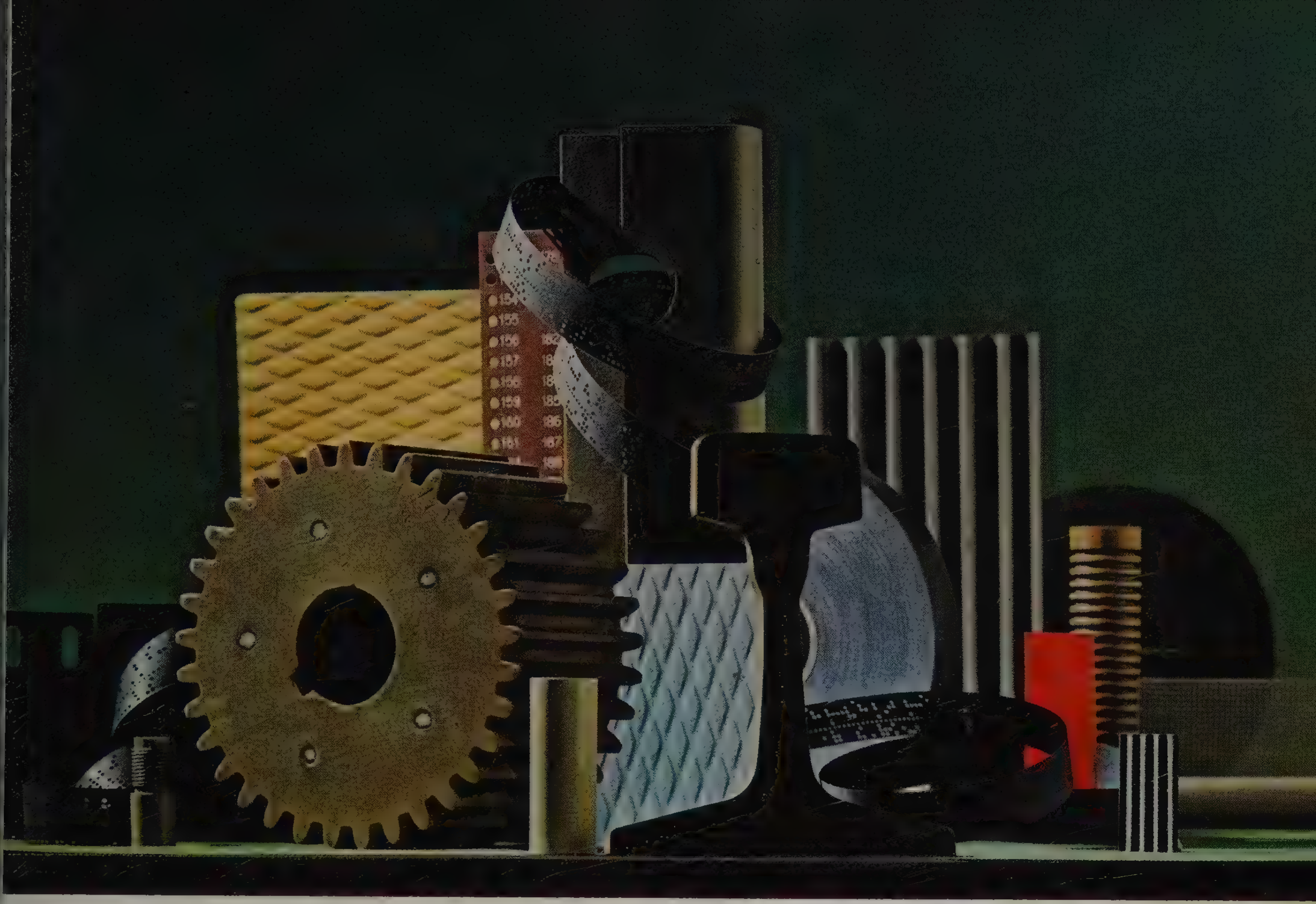

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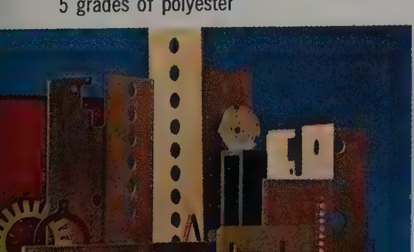

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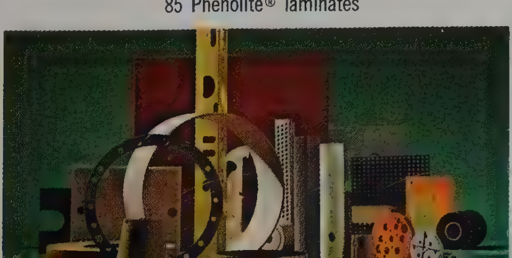

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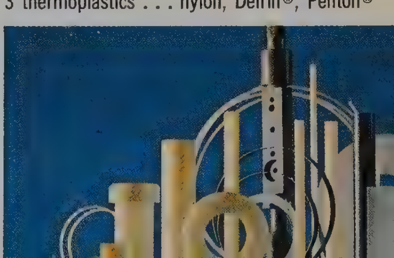

NEMA Forms New Section on Unconventional Power Generation

At a recent meeting by representatives of 22 member companies of the National Electrical Manufacturers Association, the companies decided to organize a new Unconventional Power Generation Section within the association. The scope of this latest and by far the most advanced technical industry group to affiliate with NEMA will include the following areas: magnetohydrodynamics (MHD), fuel cells, thermoelectrics, thermionics, batteries, photovoltaics, and photochemicals.

A five-man program committee, headed by Dr. Manfred Altman, consulting engineer, Missile-Space Vehicle Dept., General Electric Co., was appointed to prepare recommendations to the section concerning proposed section activities. Early projects probably will deal with Government contacts and the development of standards for basic terms, definitions, and tests.

AIEE Forms Technical Groups

The American Institute of Electrical Engineers has formulated initial plans for a system of Institute Technical Groups in an effort to provide more opportunity for active participation by members, decentralization of control, and a better means of dissemination of technical information. Details may be obtained from P. K. McElroy, chairman of the Committee on Institute Technical Groups of the Technical Operations Dept., AIEE Headquarters, 33 W. 39th St., New York 18.

Technical Session Moderators for IRE Electronics Conference

Moderators for 12 technical sessions have been announced for the 13th annual Southwestern Institute of Radio Engineers Conference & Electronics Show in Dallas, April 19-21, at Dallas Memorial Auditorium and the Baker Hotel.

The moderators and their panels are:

Dr. Harry Huskey, University of California, Berkeley, Computer Design and Computers; Dr. Gordon E. Moore, Fairchild Semiconductor Corp., Palo Alto, Cal., Semiconductor Devices; Richard D. Alberts, Wright Air Development Div., Wright-Patterson A.F.B., Ohio, Microminiature Devices and Digital Design; Maj. Jack E. Steele, M.D., Wright Air Development Div., Wright-Patterson A.F.B., Ohio, Bionics and Medical Electronics.

Also Prof. William L. Hughes, Oklahoma State University, Stillwater, Magnetic Devices; Gordon T. Bennett, Curtis Mathes Mfg. Co., Dallas, Equipment Design; Dr. William H. Hartwig, The University of Texas, Austin, Circuit Theory; John C. McElroy, Collins Radio Co., Cedar Rapids, Iowa, Communications and Telemetry; Dr. J. F. Reagan, Chance Vought Corp., Dallas, Tex., Systems; Dr. W. T. Born, Geophysical Research Corp., Tulsa, Okla., Geophysics; and Frank C. Smith, Jr., Dannemiller-Smith Inc., Houston, Tex., Industrial Electronics.

Dr. W. W. Hagerty, Dean of the College of Engineering, The University of Texas, Austin, will moderate a panel on engineering education.

Cairns Elected to Chemical Society Board of Directors

Dr. Robert W. Cairns, Hercules Powder Co., has been elected to the board of directors of the American Chemical Society. He has been active for many years in the ACS, as well as in other professional, scientific, and government organizations.

Appliance Technical Conference To Cover Insulation, Other Topics

Leakage currents, double insulation, and component reliability will be among the key topics at the 12th annual Appliance Technical Conference, Kentucky Hotel, Louisville, Ky., May 1-3. Sponsored by the Domestic Appliance Committee, American Institute of Electrical Engineers, the technical meeting is open to nonmembers. A special feature of the program will be a tour of General Electric's Appliance Park in Louisville.

Some of the papers scheduled for presentation are: Cable Heaters; Leakage Currents in Appliance Heaters; Double Insulation; Improving Moisture and Water Resistance of RAC Fan Stators; Over Surface Failure of Hermetic Compressor Motor Feed Through Terminals; and Component Reliability.

Advance registration may be made by writing: Chairman Warren F. Kindt, c/o General Electric Co., AP-2 Room 241, Louisville 1, Ky.

Harrison Named Chairman of EIA Small Business Committee

C. J. Harrison, Rixon Electronics Inc., Silver Spring, Md., has been appointed chairman of the Small Business Committee of the Electronic Industries Association.

The committee functions as industry spokesman for electronics firms within the government's "small business" definition. It also provides liaison between small concerns and the Small Business Administration.

Papers on Glass and Ceramics in May Design Engineering Conference

Two papers on glass and ceramics will be presented at the 1961 Design Engineering Show and Conference. Both events will take place at the new Cobo Hall, Detroit, May 22-25.

Because the show is being held in Detroit for the first time, the opening conference session will be entirely devoted to design engineering in the automotive field.

The two papers will be presented Tuesday morning, May 23, in Session III. They are: Glass, Ceramics, and Glass-Ceramics, by Marvin G. Britton; and Designing Parts to be Made of Glass, Ceramics, or Glass-Ceramics, by J. R. Blizard. Both men are with Corning Glass Works, Corning N.Y.

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JOHNS-MANVILLE JM PRODUCTS

Print Ins. 18 on Reader Service Card

Industry News

Net 1960 earnings of $70,692,374, or $1.38 per share of common stock, on sales of $549,675,178 have been reported by *Minnesota Mining and Manufacturing Co.*, St. Paul, Minn. These are approximate 10% increases over 1959 figures.

The *B. F. Goodrich Co.*, Akron, Ohio, has reported net 1960 sales of $764,736,162, 0.9% below 1959 sales. Net income was down 20.1%.

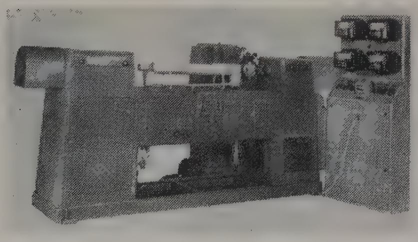
The acquisition of *Electropot Inc.*, Hawthorne, Calif., potentiometer manufacturer, by *Linair Engineering Inc.*, Inglewood, Calif., has been approved by both boards of directors.

Taylor Fibre Co., Norristown, Pa., manufacturer of laminated plastic and vulcanized fibre, has created a filament-winding division and moved its Detroit sales office to the plant of its subsidiary, *Dytronics Inc.*, in Rochester, Mich.

Two new branch offices (Denver, Colo., and Charleston, W. Va.) have been established by the *Okonite Co.*, Passaic, N. J., wire and cable manufacturing subsidiary of *Kennecott Copper Corp.*

The engineering and development divisions of *Del Electronics Corp.*, Mount Vernon, N. Y., have been moved to a new 5,000 sq ft facility. Del reports a profit of $56,598 on 1960 sales of $616,566.

Thermoplastic Equipment Corp., Stirling, N.J., manufacturer of extruders for two color applications, has been appointed to distribute the new

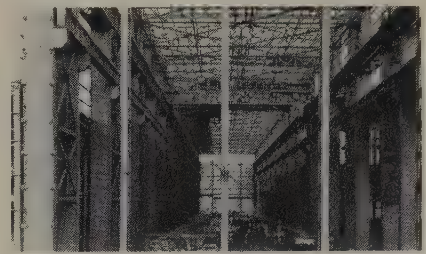


Andouart (France) Helicolor wire coating machine in the US, Canada, and Mexico.

Hercules Powder Co., Wilmington, Del., reported net sales and operating income of $336,905,000 for 1960, compared to $283,650,000 for 1959.

Net sales of *Hooker Chemical Corp.*, New York City, were $149,820,580 for its fiscal 1960, just a shade over its record sales for the preceding year. Net income, however, was down to $12,688,877 from 1959 income of $13,401,636.

Net sales reported by *Westinghouse Electric Corp.* for 1960 were $1,955,731,000, compared with $1,910,730,000 in 1959. Net income in 1960 was $79,057,000, compared with $85,947,000 in 1959. Westinghouse expects to



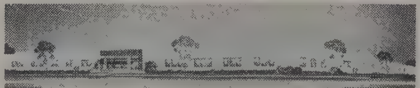
ship the first transformer from its multimillion dollar plant now under construction in Muncie, Ind., late in 1961.

West Virginia Pulp and Paper Co., New York City, has reported that sales advanced from $233 million to more than $250 million, while earnings declined from $11.8 million to $11 million in 1960.

Eicher and Co., Seattle, Wash., has been appointed to represent *Associated Research Inc.*, Chicago manufacturer of high voltage test instruments, in Idaho, Washington, and Oregon. *J. E. Redmond Supply Co.*, Phoenix, has been named to represent it in Arizona.

National Beryllia Corp., North Bergen, N.J., has named *W. E. Fry & Co. Inc.*, Kansas City, Mo., to handle its ceramic products in Iowa, Missouri, Kansas, and Nebraska. *Martin P. Andrews Inc.*, Fayetteville, N.Y., will cover New York.

Diebel Die & Manufacturing Co., manufacturer of electrical/electronic



parts, has moved to a new 35,000 sq ft plant in Morton Grove, Ill.

The *Silicone Products Dept., General Electric Co.*, Waterford, N.Y., is building a $1 million process plant there for the production of new types of intermediate silicone chemicals.

American Machine & Foundry Co., New York City, has signed an agreement to acquire the *Paragon Electric Co.*, Two Rivers, Wis., manufacturer of electrical timers and controls.

Diamonite Products Mfg. Co., Shreve, Ohio, manufacturer of high alumina ceramic components, has appointed the *A. V. Doran* organization to service the area within 250 miles of St. Louis.

Ault-Wieler Inc., Inglewood, Calif., electronic engineering representative, is a newly organized Southern California affiliate of *Ault Associates.*

General Plastics Corp., custom coating specialist, has moved to Bloomfield, N.J.

DeMambro Radio Supply Co. Inc., Boston, Mass. has been appointed distributor for *Garlock Electronics Products, Garlock Inc.*

The Electronic Tube Div., *Sylvania Electric Products Inc.*, a subsidiary of *General Telephone & Electronics Corp.*, is discontinuing receiving tube manufacturing operations at Mill Hall, Pa., and shifting production to other plants. At Buffalo, N.Y., the name of the *Amherst Engineering Laboratory* has been changed to *Amherst Laboratories* to include three newly-formed laboratories: Advanced Communication Systems, Product Development, and Product Engineering.

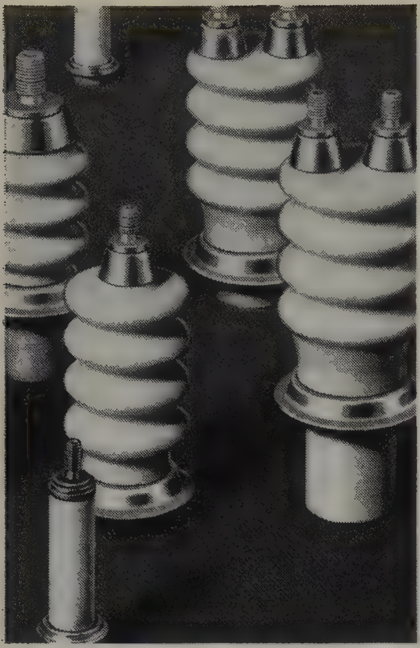
Commercial Resins Corp., St. Paul, Minn., has reduced polyester resin prices 15% (5¢ per lb).

Narda Microwave Corp., Mineola, N.Y., plans to build a 40,000 sq ft plant on a 2½-acre site in Plainview, N.Y.

The *Rome Cable Div., Aluminum Co. of America*, is now operating a new cable production facility in East Los Angeles, Calif.

New quarters in Cicero, Ill., have been leased by *Combined Electronics Inc.*, molded circuit manufacturer.

Headquarters of the *Control Switch Div., Controls Co. of America*, has



COORS STANDARD TERMINAL INSULATORS

Fast, off-the-shelf delivery ... low price

Coors standard terminal insulators are regular stock items, available for immediate shipping. They are manufactured on a regular production basis, resulting in low manufacturing costs—and low prices.

Coors Terminal Insulators give you these important benefits:

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Need special terminal insulators or metalized assemblies? A Coors Field Engineer is near you to give you ceramic design help. Call him today—or write for complete Technical Data Sheets on Coors Ceramic and facilities.

REGIONAL SALES MANAGERS

West Coast..........William S. Smith, Jr. EM 6-8129—Redwood City, Calif.
Midwest..........John E. Marozeck FR 2-7100—Chicago, Ill.
Central..........Donald Dobbins GL 4-9638—Canton, Ohio
East Coast..........John J. McManus MA 7-3996—Manhasset, N.Y.
New England..........Warren G. McDonald FR 4-0663—Schenectady, N. Y.
Southwest..........Kenneth R. Lundy DA 7-5716—Dallas, Texas
Southwest..........William H. Ramsey UN 4-6369—Houston, Texas

Coors
COORS PORCELAIN COMPANY
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been moved from Folcroft, Pa., to El Segundo, Calif. It has also purchased 83,000 sq ft of land adjacent to present buildings in El Segundo.

Alloyd Electronics Corp. will hold its Third Annual Symposium on Electron Beam Technology in Boston on March 23-24.

National Connector Corp. has moved to a new 20,000 sq ft plant in

the New Hope Science Industry Center north of Minneapolis, Minn.

The *Borden Chemical Co.* has formed three new divisions. The Resins & Chemicals Dept. and the Coatings & Adhesives Dept. have been consolidated into the new Adhesives & Chemicals Div.; the Western Operations Dept. has been made a division; and the Polyvinyl Chloride, Resinite, and Polyco-Monomer Depts. have been consolidated into the new Thermoplastics Division.

Corning Electronic Components, Corning Glass Works, Bradford, Pa., is assuming direct management of product distribution, which had been handled by *Erie Distributor Division.*

The *Electronics Div., Chance Vought Corp.*, is now located in a new facility in the Great Southwest Industrial district near Arlington, Texas. The division has also formed four operating branches: Automatic Controls, Electronic Systems, Radiation Systems, and Guidance Systems.

Jack & Heintz Inc., Cleveland electrical equipment manufacturer, has been merged into *The Siegler Corp.*, manufacturer of electronics and aerospace components.

Midwest Technical Development Corp., Minneapolis, has invested $75,000 in the recently-organized *Plastics Corp. of America*, which owns 97% of *Moxness Products*, Racine, Wis., manufacturer of silicone and fluorocarbon insulations.

W. L. Gore & Associates Inc., "Teflon"-insulated wire and cable manufacturer, has moved into a new plant adjacent to the old one in Newark, Del.

Berko Electric Mfg. Corp., electric heating equipment manufacturer, has

opened a new plant in Jamaica, N.Y.

A new plant and administrative building will be constructed on a 2-acre site in Cranford, N.J., by *Multi-Amp Electronic Corp.*, producer of electrical test instruments.

Proposed expansion at the *McDanel Refractory Porcelain Co.*, Beaver Falls, Pa., manufacturer of special industrial ceramics, will increase floor space by 25%.

The new Linden, N. J., rubber insulating plant of the *Hatfield Wire and Cable Div., Continental Copper and Steel Industries Inc.*, is now producing HV multiconductor power cables, control cables, power cords, and other cable types not previously manufactured by the company.

The *Glastic Corp.*, Cleveland manufacturer of fiber glass reinforced plastic electrical insulating materials and components, has opened a new regional sales office in Newark, N. J., to serve New Jersey, eastern New York state, and New England.

Flo-Tronics Inc., Minneapolis manufacturer of electronic, molded rubber, and plastic products, has acquired its fifth subsidiary in less than six months. Most recent was the merger of *Electric Service Systems*, Minneapolis, producer of battery and farm fence chargers and commercial transformers.

The *Spaulding Fibre Co. Inc.*, Tonawanda, N. Y., laminated plastic manufacturer, has opened a new sales office in Springfield, Mass., to serve the New England area. Branch manager is Ralph A. Brown.

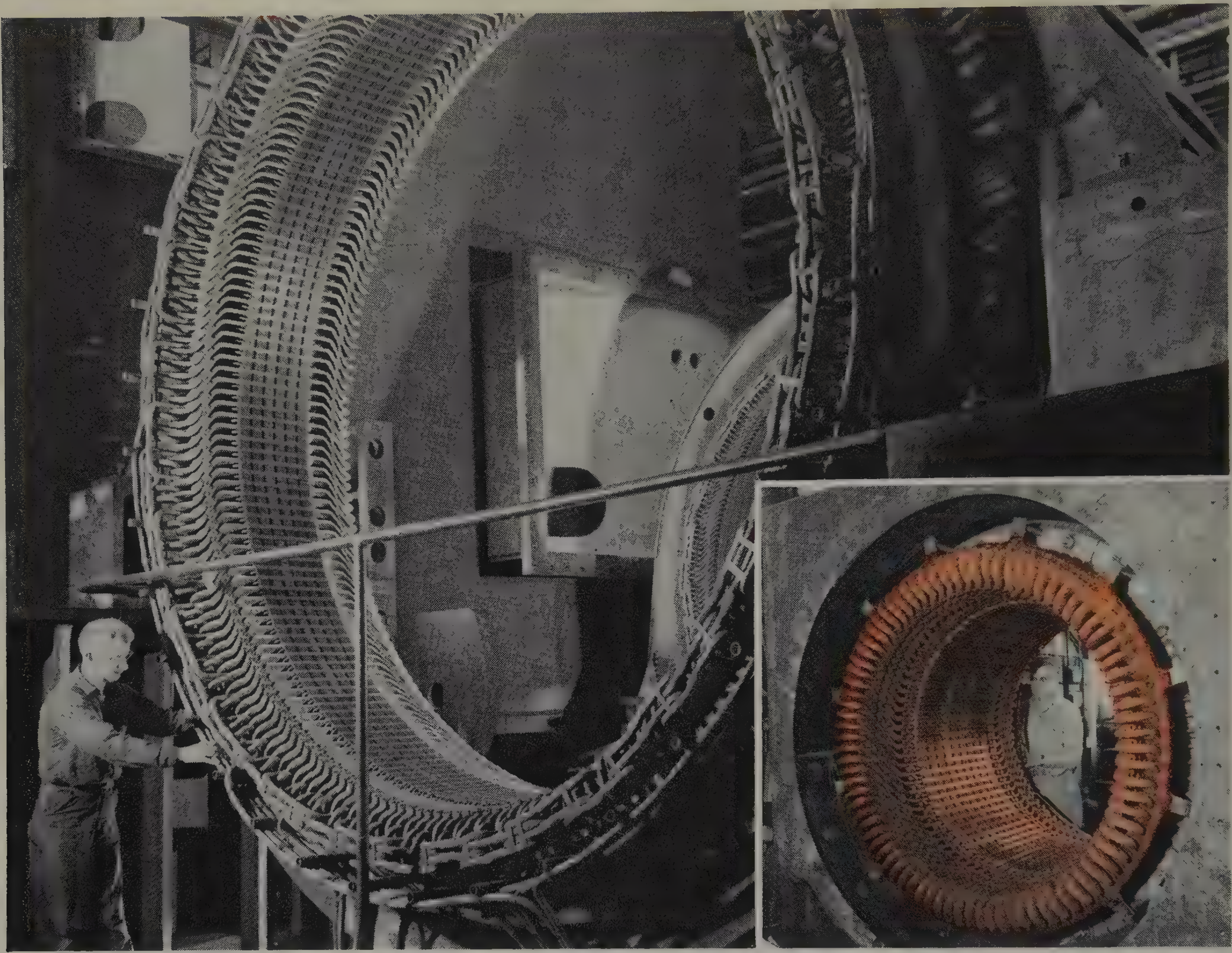
Three Point One Four Corp., Yonkers, N. Y., battery manufacturer, has acquired stock control of two Ansonia, Conn., companies: *Atlas Coils Co. Inc.* and *Cameron Electric Mfg. Co. Inc.*

Glaskyd Inc., producer of glass reinforced alkyd molding compounds, has opened a new 13,000 sq ft plant and office in Perrysburg, Ohio.

Print Ins. 22 on Reader Service C

SILICONE NEWS from Dow Corning

For Greater Reliability



Potential for Insulation Systems Made From Silastic Goes Up and Up!

Insulation systems made from Silastic®, the Dow Corning silicone rubber, are being used on more and more machines, on machines designed for higher and higher voltages.

Take the 4,500-kw, 4,160-volt engine-type generator shown above, for example. Built by Allis-Chalmers, this generator features an insulation system made from Silastic.

A midwest steel mill specified silicone rubber insulation for the 11,000-volt, 3,000-hp, Allis-Chalmers Type AKG sintering-fan drive-motor shown in the inset because of outstanding performance from similar motors designed for voltages ranging from 240 to 6,600.

Combining high temperature resistance with self-protecting qualities, insulation systems made from Silastic are winning increased acceptance for equipment subjected to moisture, heat and thermal cycling.

Silastic retains excellent electrical and physical properties from −90 to 250 C, resists arcing, ozone, corona. Vulcanized in place on coils, it forms a homogenous insulation jacket that is impervious to moisture and other contaminants. Resilient, it is unaffected by thermal cycling . . . hairline cracks do not develop.

For the best in silicone rubber insulation, specify Silastic.

Your nearest Dow Corning office is the number one source for information and technical service on silicones.

first in silicones

Dow Corning

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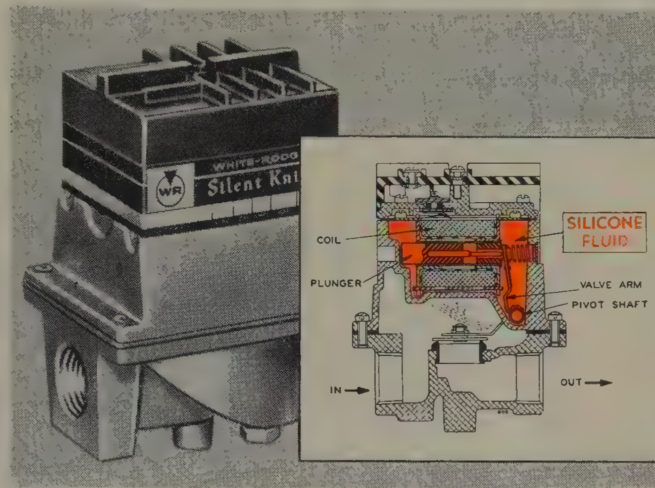
..Design with Silicones

lence Solenoids with Silicones

e entire operating mechanism of their new Silent Knight s Valve, manufactured by White-Rodgers Company, St. uis, is immersed in Dow Corning 200 Fluid. Enclosed in unbreakable metal case, the viscous fluid slows the echanism, cushions the components and makes them ent. Eliminated are the characteristic "snap" of the lay, the "hammering" of the plunger, some of the un-sirable "pop" of gas ignition. Silicone fluid is the ideal mping medium because it doesn't thicken or thin with mperature changes, has excellent dielectric properties. oncorrosive, resistant to oxidation and to breakdown nder shear, Dow Corning silicone fluid assures long-me, reliable service.

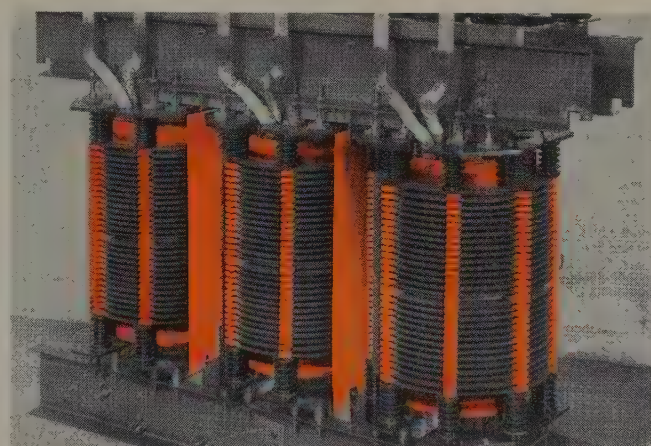
Print Ins. 23B on Reader Service Card



ut Weight with Silicone Laminates

nsulation components made from silicone-glass laminates elp improve the design and performance of electrical quipment like this 100-kva, 3-phase Pennsylvania Trans-ormer. Bonded with heat-stable Dow Corning silicone esins, glass laminates have high arc resistance, low loss actor, low moisture absorption . . . excellent mechanical nd dielectric strength even after prolonged aging at 250 C. sed with other silicone insulation components, silicone-lass laminates permit transformer designs that are lighter n weight, smaller in size, easier to install and maintain han transformers using any other class of insulation.

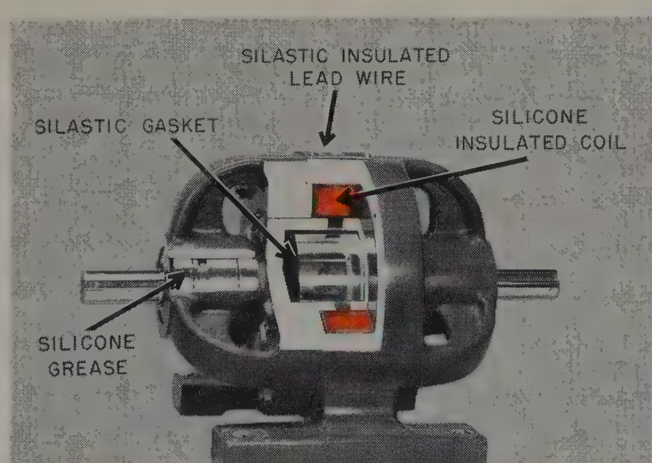
Print Ins. 23C on Reader Service Card



For Teamwork Specify Silicones

This magnetic clutch, produced by Vickers Incorporated, Electrical Products Division, Sperry Rand Corporation, assures smooth acceleration of rotating equipment without chatter or grab. Since the Magneclutch can slip continuously, heat is produced. One critical component requiring silicone protection is the excitation coil which produces the torque-producing magnetic field. Insulated with silicone components, and dipped in Dow Corning 997 Varnish, it permits operating temperatures of 180 C and better. Other Dow Corning silicone materials in the Magneclutch: mechanical gaskets, lead wire insulation, bearing lubricants.

Print Ins. 23D on Reader Service Card



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branches: ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

New Publications

Nondestructive Testing, by Warren J. McGonnagle, Argonne National Laboratory. Covers the physical principles, techniques, advantages, and limitations of the various methods of nondestructive testing, including ultrasonics and magnetic and electric techniques. 457 pages, 6" x 9", 413 illustrations, 65 tables, $15. McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36.

Environmental Effects on Materials and Equipment. A new monthly abstracts journal of literature on military and other material in all environmental conditions of transportation, storage, and use. Free for qualified federal government agencies, $25 per year for others. Prevention of Deterioration Center, National Academy of Sciences-National Research Council, Washington 25, D.C.

IEC Publications

Four new publications of the International Electrotechnical Commission are now available from the American Standards Assn., 10 East 40th St., New York 16. They are:

IEC Publication 71, Recommendations for Insulation Coordination. This document sets forth the conditions to be fulfilled by the insulation of electrical equipment—except generators, rotating machinery, underground cables, and overhead line—used in exposed installations on a-c systems having a nominal voltage greater than 1 kv. $3.20.

IEC Publication 119, Recommendations for Polycrystalline Semiconductor Rectifier Stacks and Equipments.

IEC Publication 120, Recommendations for Ball and Socket Couplings of String Insulation Units. $8.

IEC Publication 51, Recommendations for Indicating Electrical Measuring Instruments and Their Accessories. $6.

NEMA Standards

The following new publications are available from the National Electrical Manufacturers Assn., 155 East 44th St., New York 17.

TR 71-1960 Removable Cable Terminating Boxes for Power Transformers and *TR 72-1960 Integral Cable Terminating Boxes for Power Transformers.* Both publications apply to an air-filled box which is suitable for mounting on the side wall of a transformer rated 501 kva and above and with suitable provision for terminating cable. 35 cents.

WD 2-1960 Wiring Devices. Revised booklet covers the dimensions of the lamp shoulder gauge of medium-base lamps, colors of molded compounds for wiring devices, and the dimensions of openings in wall plates. 35 cents.

PB 2-1960 Dead-front Distribution Switchboards. Describes the features of Class I, II, and III dead-front distribution switchboards designed for equipment on 600 v or less application and consisting of one or more vertical sections designed for floor mounting. 25 cents.

NEMA Booklet

Electrical Porcelain. Booklet produced by the Dry Process Electrical Porcelain Section of the National Electrical Manufacturers Association concisely describes the inherent advantages and practical benefits of dry process electrical porcelain in electrical applications. Copies may be obtained from any of the four following listed companies which cooperated in its production: The Akron Porcelain Co., Cory Ave., P. O. Box 3767, Kenmore Station, Akron 14, Ohio; New Jersey Porcelain Co., Plum St. at New York Ave., P. O. Box 908, Trenton 5, N. J.; The Star Porcelain Co., Muirhead Ave., Box 1329, Trenton 7, N. J.; The Universal Clay Products Co., 1528 First St., P. O. Box 1631, Sandusky, Ohio.

OTS Publications

The following publications may be obtained from the Office of Technical Services, Business and Defense Services Administration, U.S. Dept. of Commerce, Washington 25, D.C.

PB 161 805, Research on High Temperature Ferroelectric Storage Media, by C. F. Pulvari, The Catholic University of America. 123 pages, $2.75.

PB 161 788, High-Temperature Insulation for Wire, by K. N. Harris and J. D. Walton Jr., Engineering Experiment Station, Georgia Institute of Technology. Concerns a frit-resin insulation coating for electric wire that is effective at 800°F. 40 pages, $1.

PB 161 912, Investigation of the Effects of Sea Water Immersion on the Properties of Glass Reinforced Polyester Laminates, by P. M. Goldfarb, Material Laboratory, New York Naval Shipyard. 46 pages, $1.25.

PB 161 784, Ultra-High Resistance Measurements of Plastics, by A. R. Blanck, Picatinny Arsenal, U.S. Army. A report on an Army method for measuring resistances greater than 10^{16} ohms. 14 pages, 50 cents.

SC-4466(RR), Interim Report on Development of Design Criteria for Relays. (Covers the period 1 February-31 March 1960.) 57 pages, $1.75.

SC-4519(RR), Interim Report on Development of Design Criteria for Relays. (Covers the period 1 June-31 July 1960.) 94 pages, $2.25.

SCDR-280-60, Design Criteria for Printed Circuit Boards. 65 pages, $1.75.

Other Publications

TS-5523, Recommended Commercial Standard for Schedule A, Types I and II, Polyvinyl Chloride Pipe. (Limited copies available on request from the Commodity Standards Div., U.S. Dept. of Commerce, Washington 25, D.C.

New Specifications on Waxes and Applicable Test Methods. New specifications on pure carnauba, candelilla and ouricury waxes based on certain prescribed wax sampling and test methods may be obtained from the American Wax Importers and Refiners Assn., 225 West 34th St., New York 1.

VARSLOT

the quality name for laminated slot insulation

Varslot is a lamination of selected electrical insulating materials thoroughly bonded in duplex or triplex combinations. Typical of the many Varslot materials available, for example, is Mylar* laminated to 100% rag paper. Such Varslot combinations are supplied in rolls or sheets and in a wide range of thicknesses to meet almost unlimited specific applications. Varslot characteristics include flexibility, toughness, high dielectric strength and good resistance to deterioration under heat. Combinations utilizing other electrical insulating papers or varnish-coated Fiberglas† with Mylar are also available.

- *Complete test data available on request*
- *Agents in all principal cities*

DISTRIBUTORS

Earl B. Beach Co., Pittsburgh, Pa.
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Brooks Electrical Supply Co., Inc., Baltimore, Md.
John H. Cole, Company, Oklahoma City, Okla.
Electrical Insulation Sales Co., Rutherford, N. J.
Electrical Insulation Suppliers, Inc., Atlanta, Ga.
Electric Motor Supply Company, Denver, Colo.
Hanna & Ferguson, Rochester, N. Y.
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MANUFACTURERS OF FLEXIBLE ELECTRICAL INSULATION

WOODBRIDGE, N. J.

Varnished Cambric Cloth and Tapes
Varnished "Fiberglas"† Cloth and Tapes
Varnished Silk and Silk Substitute
Synthetic Resinous Tapes and Extruded Tubing
Cable Wrapping Tapes
Polyethylene, Sheets, Tapes and Extruded Tubing
"VARSIL" Silicone Varnished "Fiberglas"† Cloth and Tapes

"VARSLOT" Combination Slot Insulation:—
Rag Paper and Vartex Varnished Cambric
Fish Paper and Vartex Varnished Cambric
Rag Paper and "Mylar"* Polyester Film
Asbestos Paper and "Mylar"* Polyester Film
Kraft Paper and "Mylar"* Polyester Film
Vartex Varnished "Fiberglas"† and "Mylar"* Polyester Film
Special combinations available upon request

*Mylar, Du Pont's registered trademark †Fiberglas, Owens-Corning Fiberglas registered trademark

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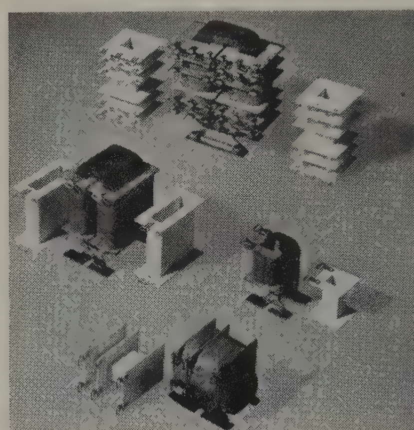
High Temperature Transformers with Silicone-Glass Bobbins

A series of transformers used in air-borne guidance control units are wound on specially formed one-piece coil bobbins made from silicone-glass laminate. The use of silicone-glass laminate qualifies the coil bobbins for class "U" (above 170°C) or class "H" (200°C) applications. Manufactured for Foster Transformer Co., Cincinnati, by Silicone Insulation Inc., Bronx, N. Y., this type of coil

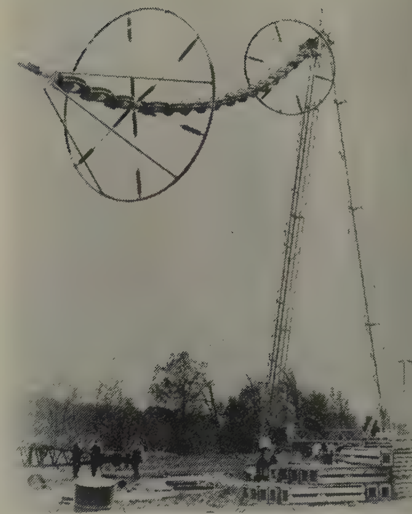


bobbin is actually being used in continuous operation above 250°C and has been tested at 400°C for 1000 hours.

These bobbins—even the tiniest—are made as hand lay-ups. The glass cloth, previously impregnated with a silicone bonding resin, is so arranged that the material from the core flows out to form the flanges, thus eliminating the usual joint. The entire lay-up is placed in a special mold and laminated into a single unit. This technique reportedly allows production to close tolerances, and the one-piece construction ensures uniform rigidity.

As a final step after assembly, Foster completely impregnates the transformers with a silicone varnish to provide extra protection and reliability.

Corona Rings for Mightiest Radio Station



The world's mightiest radio station, broadcasting for the Navy from Machias Bay, Me., with 40 times the power of any existing commercial broadcasting installation, is outfitted with special stainless steel grading or corona rings, believed to be the largest ever fabricated for use on antenna insulator strings.

The antenna system consists of 26 supporting towers interconnected by a spider web of antennae. Each antenna panel is insulated and supported from the towers at each of four points by a chain of insulator links 74 inches long. In turn each of these long strings of porcelain insulators is fitted with a pair of the giant grading rings, which form a safe gradient for 400,000 volts so that the station's power is not dissipated in corona losses or arcing.

The grading rings are fabricated in two sizes from Republic Steel's stainless steel tubing to give the needed non-magnetic properties, strength, and corrosion resistance to salt sea air.

The larger of the two corona rings has a 20-foot diameter mouth pyramided to a steel plate at the other end by six 15-foot legs. The smaller of the two rings is similar in construction with a 15-foot diameter mouth. The rings were designed by Lapp Insulator Co. Inc., LeRoy, N.Y., and furnished as part of their insulator assemblies.

Science is resourceful. It couldn't open a day-coach window, so it air-conditioned the train. *The Kablegram*

TWO PLACES TO BE . . .

. . . The New York Coliseum, June 5-9, 1961, for the 9th NATIONAL PLASTICS EXPOSITION and

The June Issue of PLASTICS DESIGN & PROCESSING for UNSURPASSED ADVERTISING VALUE and EFFECTIVENESS

YOUR JUNE ISSUE ADVERTISING WILL BENEFIT FROM . . .

- ★ **Complete Editorial Preview/Guide to the Exposition and Conference**
- ★ **Exclusive "Design/Processing Selection Guide" Editorial Feature**
- ★ **Extra Bonus Circulation at the Exposition**

Yes, the June issue of PLASTICS DESIGN & PROCESSING is more than just the normal type of show issue. Sure, it will do an extensive and thorough job on the exposition and conference so that all readers will know what new developments will be introduced, where to go, why a new product to be announced at the exposition is important, etc.

But in addition to this show coverage, the June issue will include a once-in-a-lifetime series of "tell 'em how" editorial articles—a "Design/Processing Selection Guide" that will be eagerly read, referred to, and saved. This is the type of knowledgeable editorial material that has guts . . . an exclusive editorial package keyed to the needs of the men who buy and specify your products.

Mailing of the June issue of PLASTICS DESIGN & PROCESSING is timed to reach your customers just before the exposition—they'll use it to make their plans for exhibits they intend to see, the companies they plan to contact. And in addition to the regular circulation, extra copies of PDP will be distributed at the exposition—you get this bonus circulation at no increase in advertising rates!

PDP—with its 20,000 VERIFIED, signed request CIRCULATION—is the first plastics publication which has dared to provide waste-free, effective circulation—qualified subscriptions go only to the plastics processors and volume manufacturing users.

Check the low, full-value advertising rates for PDP. Then fill out and mail the space reservation coupon below—PLEASE HURRY, THE JUNE ISSUE CLOSES MAY 1, 1961.

JUNE ISSUE EDITORIAL HIGHLIGHTS

- ★ Complete listing of exhibitors and their products and services.
- ★ Special article spotlighting new developments to be introduced at the exposition.
- ★ Extensive report giving all details on both the conference and exposition.
- ★ "Design/Processing Selection Guide"—a series of exclusive articles prepared by experts in various design/processing fields. Readers will get an up-to-date picture of materials, processing equipment, production methods, and designs to guide them in their selection of equipment and materials. Blow molding, injection molding, compression and transfer molding, extrusion, coating and calendering, laminating, reinforcing, and thermoforming will be some of the topics covered.

Yes, reserve the following space in the June 1961 issue of PLASTICS DESIGN & PROCESSING:

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PLASTICS DESIGN & PROCESSING
Lake Publishing Corp.
Box 270, 311 E. Park Ave.
Libertyville, Illinois
EMpire 2-8711

People in the News

Russell C. Spera has been named vice president in charge of production for Schaevitz Engineering, Pennsauken, N.J.

Chester C. Thompson has joined Radiation Dynamics Inc., Westbury, L.I., N.Y., as chief electronics engineer.


C. C. Thompson *J. V. Muddle*

John V. Muddle and his associate, *Joseph A. Caloggero,* former sales agents, have become New England sales representatives with headquarters in Ashland, Mass., for Rea Magnet Wire Co. Inc., division of Aluminum Co. of America.

Lee Hennessy has joined the staff of Industrial Electronic Rubber Co., Solon, Ohio, as technical director.

The Warwick Wax Division of Western Petrochemical Corp. has established a West Coast Sales District with headquarters in Pomona, Cal., and named *Lyle Christiansen* as district sales manager.

PRL Electronics Inc., Rahway, N.J., has appointed *Stephen Krsna* chief engineer.


S. Krsna *B. I. MacDonald*

Bryce I. MacDonald Jr. has been named manager of manufacturing engineering at the Silicone Products Department of General Electric Co., Waterford, N.Y. At the Pittsfield, Mass., Chemical Development Operation of G-E's Chemical and Metallurgical Div., *John J. Keane* and *Willem F. H. Borman* have been assigned to product development activities.

Emerson & Cuming Inc., Canton, Mass., has appointed *Eino J. Luoma* as physicist.

William W. Hays, with Atlas Powder Co. since 1946, has been appointed marketing manager of the Chemicals Sales Dept.

The new position of research and development supervisor in the delay line section of Corning Glass Works, Corning, N.Y., has been filled by *Richard J. Stone,* formerly with Curtiss-Wright Corp. *R. V. Hamjian* has been promoted to distributor sales manager for Corning Electronic Components, Bradford, Pa.

At General Electric Co., *Pier A. Abetti,* previously manager of G-E's EHV project, has been appointed manager of the newly-expanded Electrical Engineering Laboratory in Schenectady, N.Y. At the High Voltage Specialty Transformer Section, Holyoke, Mass., *G. E. Lewis,* formerly manager of marketing, has become manager of engineering succeeding *S. T. Maunder,* who is now advanced engineering consultant. *M. I. Alimansky,* section general manager, is now also acting manager of marketing. At the Silicone Products Dept., Waterford, N.Y., *K. J. Morray* has been named sales manager to succeed *Thomas J. March,* who is now manager of sales operations of G-E's newly-established Internal Automation Operation in Schenectady.


K. J. Morray *W. W. White*

Warren W. White has been moved up to the newly-created post of assistant director of engineering for the Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co., Anaheim, Cal.

Harry L. Hildebrand has been appointed to the newly-created position of general manager of Dytronic Inc., Rochester, Mich., die-stamped circuit manufacturing subsidiary o Taylor Fibre Co.

H. P. Roberts has been named general manager of The Siegle Crop.'s Space Systems Technolog Group, Inglewood, Calif.

The Iten Fibre Co., Ashtabula Ohio, has promoted *Wayne E. Brook* to general sales manager and ap pointed *Joe R. McMillan* Ohio distric sales manager.


W. E. Brooks *J. R. McMillan*

Philip A. Thomas has been pro moted to assistant director—develop ment for Union Carbide Plastics Co Bound Brook, N.J.

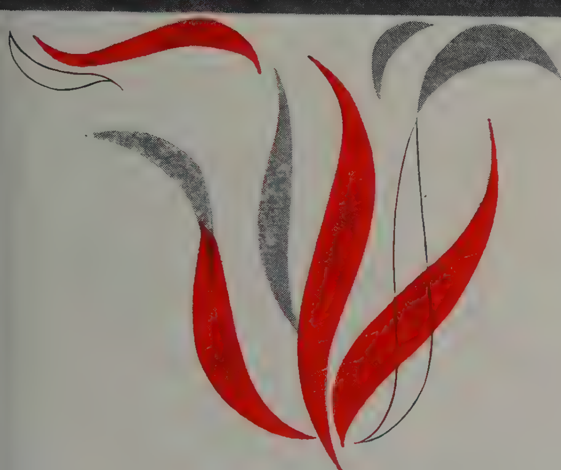
James J. Keegan, formerly desig engineer with Precision Transforme Corp., has joined Special Electric Co Chicago, as an application engineer

Loral Electronics Corp., New Yor City, has appointed two new divisio managers: Boris Cohen for the Anti Submarine Warfare Div. and Sant Scibilia for the Passive Detection Di Cohen has been with the compan since 1952 and Scibilia has been wit it since 1948.

At Clarostat Mfg. Co. Inc., Dove N.H., resistor manufacturer, *Pa Harris* has been appointed staff eng neer.

Raymond C. Mildner, former chie technical officer of Telegraph Con struction and Maintenance Co., Ltd England, has joined the Plastics Dept Dow Chemical Co., Midland, Mich as a technical specialist in dielectri insulation for power and communica tion cables. (*Continued page 68*

For the first time phenolic XXXPC laminates with...



both FLAME RETARDANCE and COLD PUNCHABILITY

New Resinox 495 Varnish makes it possible for the first time to produce phenolic laminates with both flame retardance and excellent cold punching characteristics. Paper-based laminates impregnated with Resinox 495 meet the electrical, physical, and mechanical requirements of NEMA standards for XXXP and XXXPC copper-clad laminates—yet they cost far less than other laminates with equivalent properties.

Laminates made with Resinox 495 are especially recommended for printed circuits used for commercial radio and TV applications, and as copper-clad laminates for electronic computers and military applications, or for any other application where flame retardant laminates are desirable or mandatory. Use coupon below for additional data, and list of leading laminators now supplying laminates made with Resinox 495.

RESINOX: REG. U. S. PAT. OFF.

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MONSANTO INITIATOR IN **PLASTICS**

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MONSANTO CHEMICAL COMPANY, Plastics Division
Room 808, Springfield 2, Mass.

Please send me technical data bulletin on Resinox 495, also list of laminators supplying laminates made with it.

NAME__________ TITLE__________

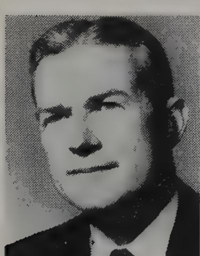
COMPANY__________

ADDRESS__________

CITY__________ ZONE_____ STATE__________

Lester E. Johnson, previously in plastics sales with Crystal-X-Corp., has joined the Philadelphia sales staff of Commercial Plastics & Supply Corp., New York City.

Robert B. Fulton has been elected president of the Sequoia Wire and Cable Co., a wholly-owned subsidiary of Anaconda Wire and Cable Co. He is replaced as manager of Anaconda's Orange, Cal., plant by *Charles E. Van Hoy*, formerly assistant superintendent at the company's Muskegon, Mich., plant. *James P. Ruch*, previously assistant superintendent at the Marion, Ind., plant, replaces Van Hoy in Muskegon, and *John A. Barris* has been moved up from assistant superintendent to superintendent of the Sycamore, Ill., plant. *Frank B. Dickey* has been named to the newly created position of manager, Magnet Wire Div. New manager of sales for the Government and Defense Div., succeeding retiring Max Rubenstein, is *William S. Shanahan*, formerly district sales manager in Philadelphia. *Edward J. I. Davies* replaces Shanahan in Philadelphia.


R. B. Fulton


C. E. Van Hoy

At the Norton Co., Worcester, Mass., *Ralph F. Gow* has been elected president. *John Jeppson* succeeds him as executive vice president. *Milton P. Higgins*, president since 1946, has stepped up to chairman of the board succeeding *George N. Jeppson*, who remains on the board as honorary chairman.

Several staff changes have been made by Sylvania Electric Products Inc., subsidiary of General Telephone & Electronics Corp. At Waltham, Mass., *Dr. Ward C. Low* has been appointed senior staff specialist — development planning, and *Curtis A. Haines* has been named vice president—product and facilities planning, Sylvania Electronic Systems Division. *Edward W. Doty* has been promoted to manager of the division's Product Development Organization. *Charles E. Jacobs Jr.* has been appointed a project manager at the Waltham Laboratories. In Needham, Mass., *Richard B. Bean* has been made program manager of the Systems Engineering and Management Operation, and *J. L. Clark* has been appointed manager of the BMEWS program. *Dr. Robert M. Bowie*, vice president of General Telephone & Electronics Laboratories Inc. and general manager of its Bayside (N.Y.) Laboratories, has been assigned to the New York headquarters staff of GT&E Laboratories. *Dr. Bernhard E. Bartels* has been elected a vice president and appointed director of research at Bayside. *Dr. Rudolph G. E. Hutter* has been appointed chief engineer, Microwave Device Operations of the Electronic Tube Division in Mountain View, Calif., and Williamsport, Pa.

John C. Soult has been assigned to the Chicago district sales office, Continental-Diamond Fibre Corp., Newark, Del.

Robert C. Bennett Jr., president of Wheatland Electric Products Co., Carnegie, Pa., has been elected a director of Barker & Williamson Inc., Bristol, Pa., manufacturer of electronic equipment and components.


R. C. Bennett


M. L. Roth

Alpha Wire Corp., New York City, has appointed *Martin L. Roth* distributor sales manager.

John V. McGuire has been promoted from assistant general manager to general manager of the Allis-Chalmers Pittsburgh Works. He succeeds *D. A. Griffith*, now serving as purchasing agent there.

The Western Petrochemical Corp. has appointed *Charles Rand Jr.*, formerly with Hooker Chemical Co., as Midwest district sales manager.

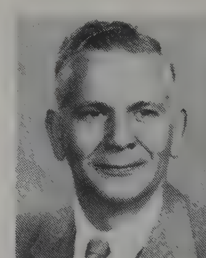
Mycalex Corporation of America has appointed *Henry Harfield* a member of the board of directors an
named *Michael Forrestal*, son of th
wartime Secretary of the Navy, secre
tary. Both are members of a Ne
York law firm.


H. Harfield


M. Forrestal

New appointments at the CALMA
Div., California Magnetic Contro
Corp., North Hollywood, Calif., in
clude: *J. B. Berger*, vice president an
manager of the equipment section
Kenneth Zehner, chief engineer fo
the component section; and *Arnol
Jarmaine*, sales manager.

Edward C. Telling has been name
manager of the Carriage Goods Div
The Brewer-Titchener Corp., Cort
land, N.Y., manufacturer of electrica
pole line hardware.


E. C. Telling


W. G. Stiffler

Walter G. Stiffler has joined th
Reliance Electric and Engineerin
Co., Cleveland, as senior insulatio
engineer.

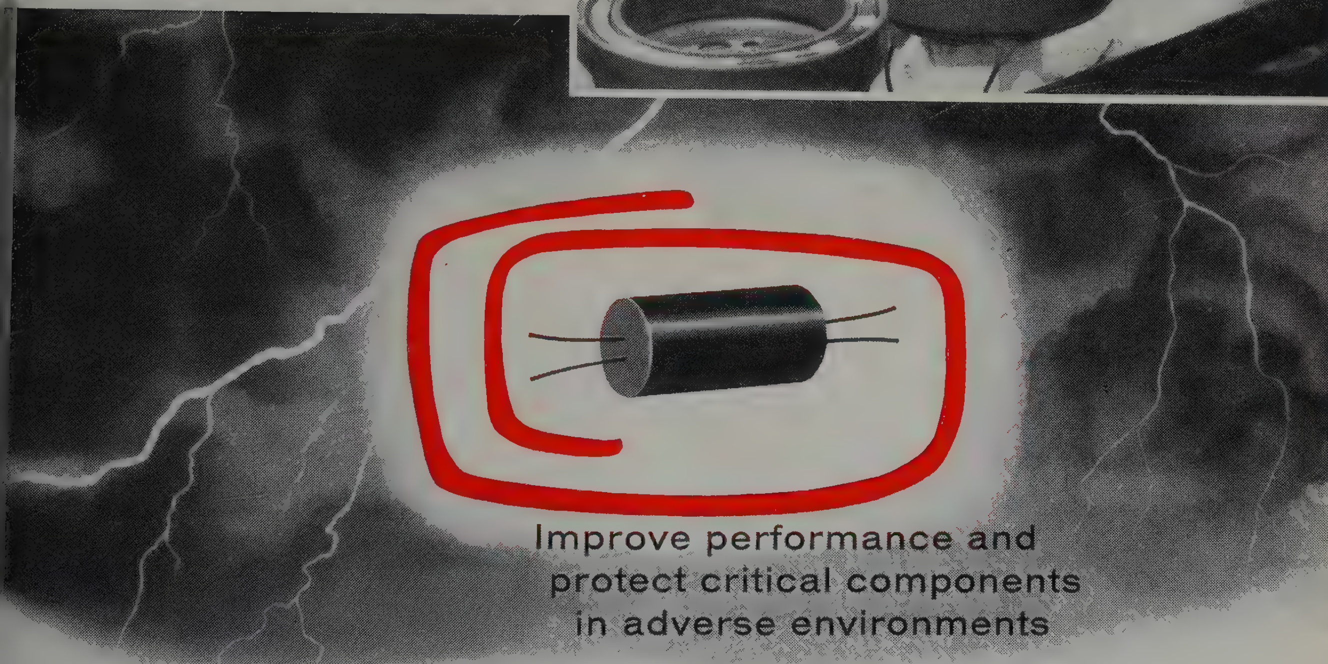
Kenneth G. Llewelyn has bee
named president of New York Trans
former Co. Inc., Alpha and Phillips
burg, N.J. He is succeeded as vic
president and general manager b
Martin E. Zernick, formerly with Gen
eral Electric Co.

Consolidated Electrodynamic
Corp., Pasadena, Calif., has promote
Herbert I. Chambers to director o
engineering for its new Data Record
ers Div. Department manager appoint
ments in the division include: *John P
Moffat Jr.*, Datagraph engineering
Fred F. Grant, Datatape engineering
John J. Smith, custom products; an
Edgar E. Hotchkin, magnetic head

For Greater Reliability—

RCI EPOTUF

Epoxy Resins



Capacitors, coils, and electronic "building blocks". . . Miniature transformers, and transmission line transformers . . . Printed circuits, relays, terminal boards and other electrical and electronic assemblies can be made to perform with higher reliability when they are impregnated, potted, or encapsulated with epoxy. And when the materials used are based on RCI EPOTUF epoxies, you are using the epoxies produced by the most modern process to achieve continuous product uniformity and high quality. In fact, the low residual hydrolyzable chlorine in RCI EPOTUF epoxies also makes it possible to achieve higher electrical properties.

For information on epoxy resin formulators who use EPOTUF epoxy resins and hardeners, or for data on pure EPOTUF resins and special curing agents, get in touch with RCI.

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Phthalic Anhydride
Maleic Anhydride • Ortho-Phenylphenol • Sodium Sulfite
Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenate
Sulfuric Acid • Methanol

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REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

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New Products

For further information on these products print the item number on the Reader Service Inquiry Card on the back cover. Fill out and mail the card —no postage is required. Insulation *will immediately forward your inquiry to the manufacturers concerned so that they can send you more information promptly.*

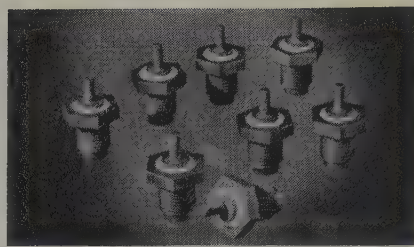
Flexible Flake Glass Composite Insulation

New flake glass paper reportedly can be fabricated into a broad range of composites in all temperature classes of flexible electrical insulation for motors, generators, transformers, coils, and wire and cable applications. Three current composites consist of flake glass paper laminated to "Mylar" film and/or woven glass cloth. Since the flake glass paper can be bonded to a great number of other materials, it is thought that an almost unlimited range of functional properties or characteristics can be "tailored" into composite insulations. Realistic applications for flake glass paper composites are said to exist where composites of mica paper, mica splittings, or asbestos papers are now being used. The flake glass paper can be combined with electrical grade papers, woven glass cloth, Mylar film, varnished glass cloth, nonwoven synthetic fiber mats, etc. The flake glass paper reportedly compares in price with rag paper and asbestos papers, and is approximately one-third the cost of mica paper or mica splittings. Brochure and samples available. Milam Electric Mfg. Co., 1100 Elmwood Ave., Providence 7, R.I.

Print No. Ins. 100 on Reader Service Card

Precision-Moldable Ceramoplastic For Use to 1200°F

New "Supramica" 620 BB ceramoplastic electronic insulation is said to operate at 1200°F, to mold to intricate shapes with superior accuracy, and to provide a true hermetic seal (photo shows chip detector plugs hermetically sealed with molded 620 BB). It



is also claimed to be resistant to nuclear radiation and impervious to humidity, oil, water, and organic solvents. Other advantages cited are high dielectric strength (270 vpm), excellent arc resistance (300 seconds), negligible electrical loss (.020 loss factor at 1 megacycle), and high electrical resistance (1 x 10^8 ohm—cm at 932°F). Mycalex Corporation of America, 30 Rockefeller Plaza, New York, N.Y.

Print No. Ins. 101 on Reader Service Card

Clad Epoxy-Paper Laminate with High Strength, Consistent Electricals

A new copper-clad epoxy resin-paper base laminate has been developed for printed circuit and other electronic applications requiring high strength and consistent electrical properties over a wide range of humidity levels. The new material, grade 65M24, reportedly withstands a wider range of humidity than do superior grades of phenolic resin/paper base laminates and is less expensive than NEMA G-10 and G-11 glass base/epoxy resin laminates. It is also said to afford good punchability at room temperature and to be superior to standard cold punch phenolic-paper based laminates in flexural strength (24,000 psi with the grain), bond strength (9 lbs average), and solder resistance (20 seconds to solder at 500°F). It is classed as a non-burning material. Electrical properties cited include: a dissipation factor of 0.034 at one megacycle; dielectric constant of 4.5 at one megacycle (after 24 hrs immersion in water at 50°C); insulation resistance of 100,000 megohms; volume resistivity of 1,000,000 megohms-cm; and a surface resistance of 1000 megohms (after 96 hrs' conditioning at 34°C and 90% RH) Micarta Div., Westinghouse Electr Corp., Hampton, S.C.

Print No. Ins. 102 on Reader Service Ca

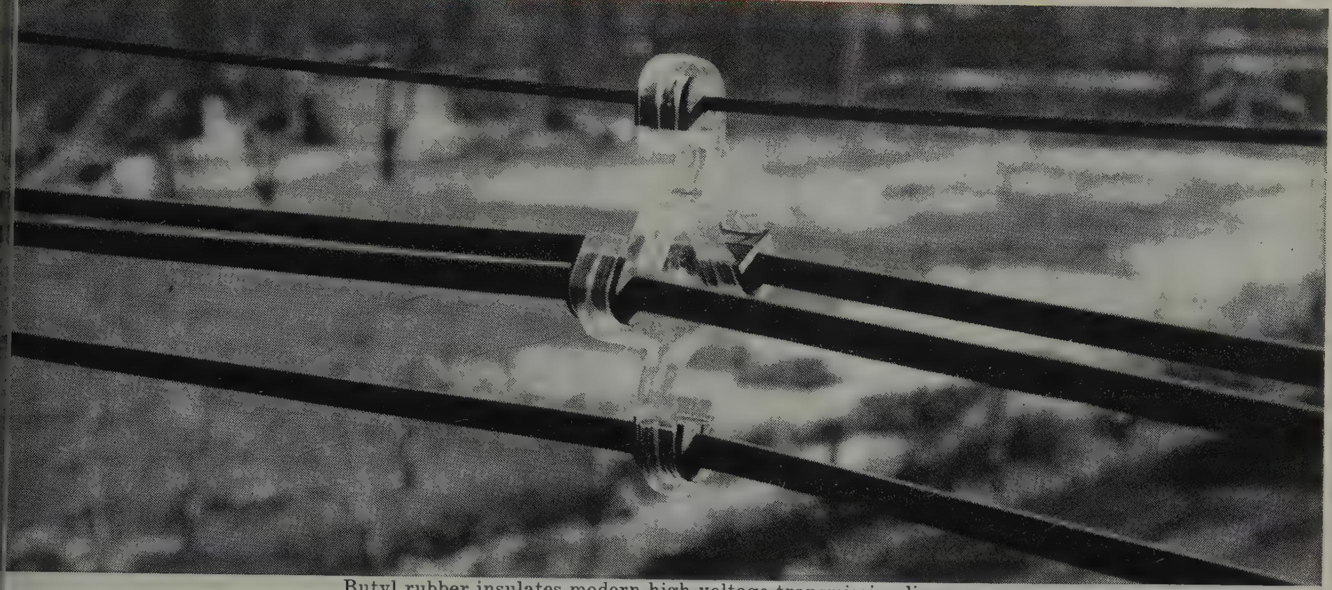
Urethane Elastomer Resin for Fast Molding and Extruding

Mass production of urethane ela tomer items by fast, low-cost injectio and transfer molding or extrusion possible with a new resin, trad named "Texin". Supplied in granula form to molders and extruders, reportedly cuts part-forming time fo cured urethane elastomer parts fro hours to seconds. Previously, produ tion of urethane elastomer items e tailed a liquid casting method. Extru sion of the urethane elastomer stoc for tubing, profiled channeling, an cable jacketing is also expected to b practical. Major properties reporte for Texin are exceptional toughness resistance to abrasive wear, oils, an solvents; plus a combination of hard ness with elasticity. Mobay Chemica Co., Pittsburgh 5, Pa.

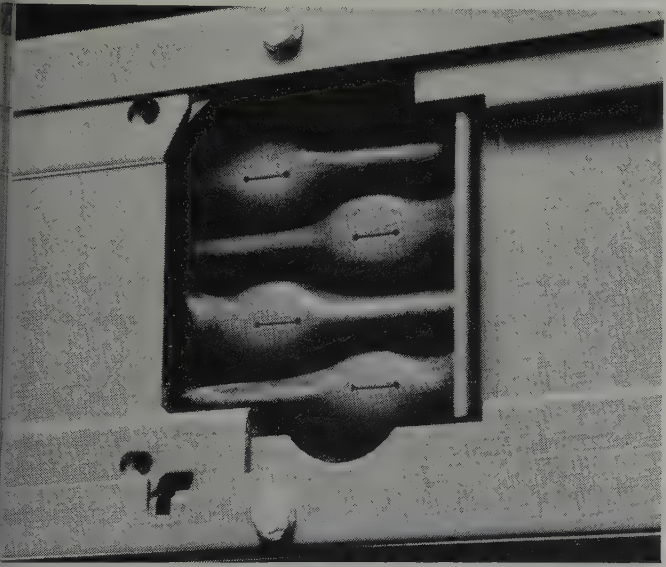
Print No. Ins. 103 on Reader Service Ca

Printed Circuit Protective Coating

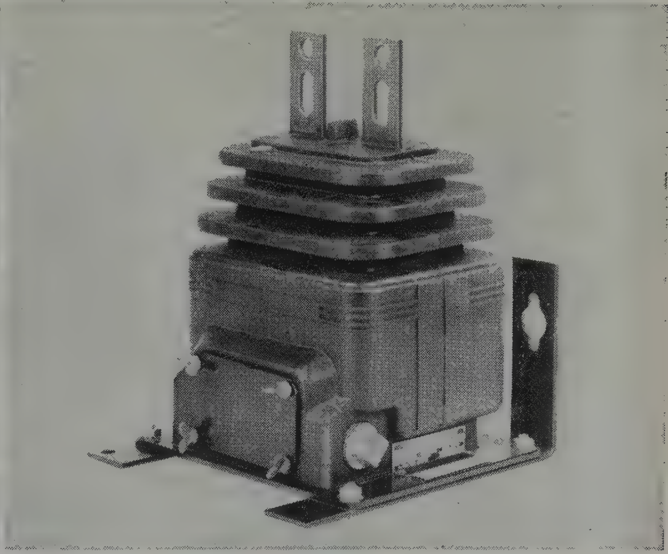
Hexcel 1260 is a new polyurethan two component, non-toxic, thermose ting, film-forming coating for the pr tection of circuit boards. It is said t provide a dielectric strength of 100 vpm, dielectric constant of 1.4, exce lent water and solvent resistance, an to set dry to the touch in an hou Baked at 160°F for two hours, it r portedly has a Sward hardness of 3 and rates 60 in flexibility (impact pe centage). The solution has an 8-h pot life and, containing 56% solid is suitable for brush, dip, or spra application. One component contai a solution of a high molecular weig polyisocyanate, with very little exce diisocyanate present. The other com ponent is a solution of polymer polyol with suitable additives to pr vide fast cure, good wetability, surface and bubble release. Replac ments can be made by solderin through the coating which will me



Butyl rubber insulates modern high-voltage transmission lines.



Butyl rubber insulates modern bus duct systems.



Butyl rubber insulates modern high-voltage transformers.

ENJAY BUTYL

best way to handle electricity

njay Butyl tops all vulcanizable ubbers in electrical and dielectric roperties . . . in resistance to corona nd ozone breakdown and water ab- orption. Its high dielectric strength nsures against electric breakdown nder normal or surge voltage. Its eat resistance permits higher cur- ent flow for a given conductor size. utyl also offers outstanding resist- ance to weathering and sunlight . . . chemicals . . . abrasion, tear and flex- ing . . . superior damping properties ...unmatched impermeability to gases. Result? Butyl is ideal for wire and power cable, transformers, tapes, bus bars, and other insulation applications.

Find out how this versatile rubber can improve your product. Contact Enjay at 15 West 51st Street, New York 19, N. Y. Enjay does not make insulation. It supplies Butyl rubber to manufacturers of scores of different electrical products.

XCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY BUTYL

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back cleanly. Hexcel Products Inc., P. O. Box 277, El Segundo, Calif.
Print No. Ins. 104 on Reader Service Card

Flame-Retardant, Cold-Punching Glass Fabric-Epoxy Laminate

A new NEMA G-10 glass fabric-epoxy laminate features flame retardancy (zero extinguishing time), superior cold-punching, and increased solvent resistance. The grade is offered copper-surfaced as Di-Clad 614 or plain as Dilecto 614. A principal application for Di-Clad 614 is as printed circuit boards in ground and airborne computers. Fabricated parts made from 614 reportedly show that "haloing" and edge-lifting are virtually eliminated, allowing closer and more intricate hole punching which

provides better plated-through holes and superior circuit reliability under humid conditions. The grade can be fabricated satisfactorily at normal room temperatures and does not soften under exposure to trichloroethylene vapors to the extent that conventional epoxies do. Grade 614 also meets NEMA specifications for NEMA FR-4, a fire retardant G-10. Military specs MIL-P-13949B, type GF, are met by Di-Clad 614, and Dilecto 614 is pending approval under MIL-P-18177B as type GEE. Continental-Diamond Fibre Corp., Newark 17, Del.
Print No. Ins. 105 on Reader Service Card

Improved Polyethylene Resins For Wire Coatings

A new line of high-density polyethylene resins, trademarked "Fortiflex" R, are reported to offer greater toughness and processing versatility for a broader range of product applications and markets than conventional linear polyethylene. Initial volume end uses foreseen for Fortiflex R

resins include automobile and appliance parts and electrical wire coverings. Extensive market test applications reportedly have indicated that wire coating can be extruded from the resins at substantially faster rates. Celanese Corp. of America, 180 Madison Ave., New York 16.

Print No. Ins. 106 on Reader Service Card

Class H Insulating Rod Stock

"Vitac" is a new class H insulating rod stock combining fiber glass reinforcement with a new high temperature resin system. The rod stock is engineered for duct-spacer sticks in class H dry-type transformers and other insulating/structural applications calling for 180°C performance. Properties are said to equal or exceed those of silicone-glass rod (flexural strength as received and after 200 hrs at 250°C (photo) is 25% higher than silicone, and compressive strength after 200 hrs at 250°C is as much as three times that of silicone). Price reportedly is approximately 25% less than published prices for silicone rod. Property data and samples available. The Glastic Corp., 4321 Glenridge Road, Cleveland 21, Ohio.

Print No. Ins. 107 on Reader Service Card

Glass Base Epoxy is Flame Retardant and Easily Fabricated

A new grade of glass base, flame-retardant, epoxy resin laminate has been developed to meet the demand for a more easily fabricated flame-retardant epoxy. New G-10-839 has a natural translucent green color. In 1/16″ thickness, it can be sheared and punched with minimum heating. Dielectric breakdown parallel to laminations, step-by-step test (condition A, D-48/50) is 52.2 + kv. Insulation resistance (ASTM taper pin, C-96/-35/90) is reported as 141,000 megohms. G-10-839 can be furnished copper-clad, and is said to meet the requirements of MIL-P-13949. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N.Y.

Print No. Ins. 108 on Reader Service Card

Improved Intermediate Cures Epoxy Resins

An improved intermediate for use as a curing agent for epoxy resins is said to be more stable under acceler-

ted heat tests and considerably lighter in color. The product, meta phenylene diamine, ranges from light gray to tan flakes. It reportedly has no ammonical odor and offers a setting point of 62.6% minimum, strength to 99.3% minimum, and is insoluble in hydrochloric acid to 0.1% maximum. National Aniline Div., Allied Chemical Corp., 40 Rector St., New York 6.

Print No. Ins. 109 on Reader Service Card

Porous Alumina for High Temperature, High Power Arc Applications

A porous alumina has been developed for use as insulation in high temperature, high power arc applications, such as circuit breakers, lightning arresters, arc diffusion systems, and others. Porous alumina resists the temperature of a high-powered arc. It also helps dissipate the energy of the arc through outgassing and the rough, porous surface permits the plasma of the arc to seek out each individual cavity or depression. The air within the pores of the material structure expands from the heat of the arc and tends to quench the arc. Other features cited are impact strength (two to three times that of zirconia) and light weight. Electronic Mechanics Inc., 101 Clifton Blvd., Clifton, N.J.

Print No. Ins. 110 on Reader Service Card

Color Stabilized Polycarbonate Resin

A color stabilized grade of "Lexan" polycarbonate resin is stated to offer improved appearance and better optical qualities. Identified as Lexan 101, it reportedly has the same excellent physical, electrical, and chemical properties associated with the earlier Lexan 100. However, the 101 resin will exhibit luminous transmittance values 5-10% higher because darkening during processing and molding is prevented by the color stability additive. The new grade is expected to expand opportunities for polycarbonate resin in electrical and electronic housings, aircraft instruments, light diffusers, and other components where transparency and translucency are important. General Electric Co., Chemical Materials Dept., Pittsfield, Mass.

Print No. Ins. 111 on Reader Service Card

Hardeners for Epoxy Systems

A new hardener designated "Aral-

dite" DP-125, is a low-viscosity, modified polyamine developed for curing Araldite DP-437 flexible epoxy resin or blends of DP-437 and other liquid epoxy resins. Systems employing the new hardener can be cured at room or elevated temperature. Advantages reported are: low initial viscosity of resin-hardener mix (1000-1500 cps), excellent elongation properties with good tensile strength, excellent resistance to age hardening (no change after 90 days at room temperature), and similar end properties result from systems cured at room temperature or at 100°C. Recommended applications include adhesives, caulking and sealing, electrical potting, impregnating, and others. Information and samples available. A second epoxy curing agent, Araldite DP-116, cures at room temperature in 45 seconds to five minutes depending on thickness of sample. The hardener is particularly suitable for electrical repair kits and for laminating and "gel" coats. In addition to its rapid curing, DP-116 is stated to offer the following advantages: easy mixing ratios, viz. 50 parts per 100 parts of resin; nonflammable; none or very little fuming on gellation; and lower exotherm during cure. Experimental samples and further information available. CIBA Products Corp., Fair Lawn, N.J.
Print No. Ins. 112 on Reader Service Card

Glass-Epoxy Laminate With Close Tolerance Thickness

A glass-epoxy laminate with a thickness tolerance of ±.004″ on 1/16″ sheets is said to be micrometer-rated over 100% of the sheet area, exceeding the class II tolerances of MIL-P-13949B (±.005″). Industrial grade FF-91 was developed as plug-in connector material for electronic computers. The new laminate is available copper clad or unclad. Formica Corp., a subsidiary of American Cyanamid Co., 4614 Spring Grove Ave., Cincinnati 32, Ohio.
Print No. Ins. 113 on Reader Service Card

Polypropylene with Wide Range of Flow Rate and Impact Resistance

New "Tenite" polypropylene is offered in an extremely wide range of flow rates and a wide variety of impact-resistant formulas. In elec-

trical applications such as extruded wire coverings, its low ash or residue is said to be advantageous (low dissipation factor required for high frequency insulation is largely dependent upon a low ash content in the resin). Other properties listed include heat resistance, surface gloss, hardness and stain resistance, stiffness, flexibility, processability, chemical resistance, stress crack' resistance, and dimensional stability. Eastman Chemical Products Inc., Plastics Div., Kingsport, Tenn.

Print No. Ins. 114 on Reader Service Card

Cast Epoxy Rod for Electronic Winding Forms

Formulated to meet the most rigid specifications when used for precision wirewound resistors under MIL-R-93B, a new line of cast epoxy rod materials, BMCO 2000 series in standard colors and diameters, is available with a wide selection of various types and percentages of inert fillers. Properties featured are high volume resistivity at high temperatures (0.19 x 10^{16} @ 180°C) and high heat distortion (133°C @ 264 psi). These rods reportedly can be machined economically using conventional shop techniques. Resistor bobbins and thin wall shells machined from this epoxy material give evidence of maintaining excellent dimensional stability. Boonton Molding Co., Boonton, N.J.

Print No. Ins. 115 on Reader Service Card

Three DAP Molding Materials For Electrical/Electronic Uses

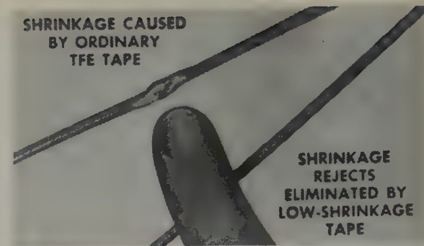
Three new reinforced diallyl phthalate molding compounds include: *RX 1260*, a flame-resistant, mineral-filled diallyl phthalate free from magnetic particles. The material, which conforms to MIL-M-14E, Type MDG, reportedly offers outstanding electrical properties even after exposure to high humidity. Other features reported are excellent dimensional stability, chemical resistance, and superior moldability, particularly around metal inserts. It is recommended for electrical and electronic components such as connectors, terminal boards, potentiometers, and computer program-boards. Generally similar to RX 1260 but compounded for temperature resistance up to 500°F, *RX 1280*

is a mineral-filled diallyl isophthalate molding compound which conforms to MIL-M-14F, Type MDG. Low mold shrinkage is said to permit mold interchangeability with other high temperature molding compounds, such as low-loss phenolics. It is not classed as flame-resistant. A glass fiber reinforced material in the isophthalate group, *RX 1380* also offers temperature resistance up to 500°F and conforms to MIL-M-14F, Type SDG. Its stated excellent electrical properties in the presence of moisture, high strength, heat resistance, and dimensional stability recommend it for critical insulation and structural applications. Rogers Corp., Rogers, Conn.

Print No. Ins. 116 on Reader Service Card

Low-Shrinkage 'Teflon' Tape For Insulating Wires

Reject rate of small diameter braid jacketed cable reportedly can be reduced from 10% to less than 1% by employing a new low-shrinkage Teflon (TFE resin) tape. The improved product is a regular skived tape with controlled low-shrinkage—no more than 2% change in any dimension when heated at 730°F for 15 minutes. Other properties cited include tensile strength at .003″ of



4000 psi minimum and elongation of 300% minimum, and dielectric strength of 2700 vpm minimum. Dixon Corp., Bristol, R.I.

Print No. Ins. 117 on Reader Service Card

Epoxy Powder for Spray-Coating Electrical/Electronic Parts

A one-part epoxy resin powder introduced as an aerated bed coating for insulation of electrical and electronic parts can also be applied successfully by the spray method. Spray application of "Scotchcast" electrical resin No. XR-5026 by means of a flocking type gun reportedly offers advantages over other methods of application when objects to be insulated require partial coating or extensive

masking. Parts especially suited to this method are transformer cans and covers, computer racks, phone equipment mounting racks, switch covers and boxes, and other items requiring a protective and insulating coating on only one side or over a particular area. Coatings ranging in thickness from approximately 5 mils to 30 mils or more are said to be possible. XR-5026 is designed for use wherever a tough, permanent moisture and chemically resistant insulation coating is needed. The one-part powder requires no weighing or mixing, and presents no pot life or shelf life problems when stored in a cool, dry location. The cured resin adheres well to metals, ceramics, and glass without special priming, other than thorough cleaning by shot or sandblasting, or in a solvent such as methylene chloride. The cured resin is stated to exhibit

strong thermal shock and impact resistance and to be suitable for continuous operation at 155°C, with short time operation at 180°C. Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.
Print No. Ins. 118 on Reader Service Card

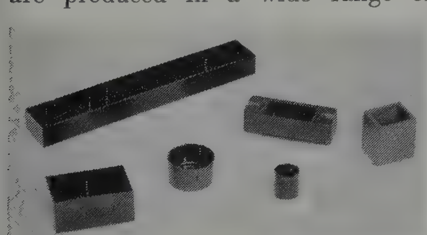
Low Loss Laminating Resin for High Temperature Electronic Uses

Eccomold L-70 is said to be an extremely low loss laminating resin which, when used in conjunction with quartz or fiber glass fabric, results in laminates capable of 500°F. Polypropylene fabric can be used with it

to make low dielectric constant laminates for use in radomes, printed circuit boards, waveguide windows, antenna insulators, and other critical electronic applications. L-70 is a one-component material. The dielectric constant of a laminate made with L-70 and polypropylene fabric is stated to be K2.15 with a dissipation factor of 0.0008. Emerson & Cuming Inc., Canton, Mass.
Print No. Ins. 119 on Reader Service Card

Molded Electronic Component Cases for Plug-in Modules

A line of molded electronic component cases with pre-positioned pins or terminals for plug-in applications are produced in a wide range of



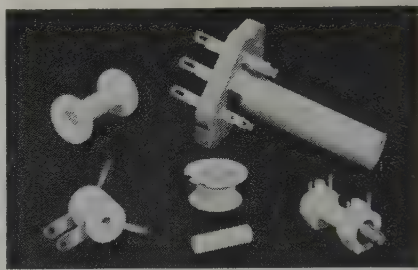
round, square, and rectangular shapes and sizes. Epoxy is generally used because of its compatibility with the potting compounds used to encapsulate the components within the case. Phenolic or other materials can be used. These plug-in cases allow the components to be assembled directly into the case without separate headers. The cases, serving as molds during

the potting of the electronic components, become integral with the encapsulated components. Wire leads may be supplied in place of the pins or terminals. Plastronic Engineering Co., 721 Boston Post Rd., Marlborough, Mass.

Print No. Ins. 120 on Reader Service Card

Glass-Bonded Mica Coil Forms

Coil forms molded or machined from Mykroy 761 and 750 are said to provide excellent characteristics for induction coils, relays, solenoids, potentiometers, and resistors. Features reported include no outgassing through 350°C, no fraying or dust particles, thermal expansion coefficients matching those of the fine platinum and nickel-chromium alloy wires



used in winding potentiometer coils, infinite dimensional stability and permanent rigidity, no moisture absorption, a loss factor of less than 0.016 at 1 meg, and a dielectric strength of +350 vpm. Mykroy coil forms, molded to precise tolerances, are produced only to customer specifications. Prototypes can also be machined from stock sheets. Electronic Mechanics Inc., 101 Clifton Blvd., Clifton, N.J.

Print No. Ins. 121 on Reader Service Card

Varied Line of Prepregs

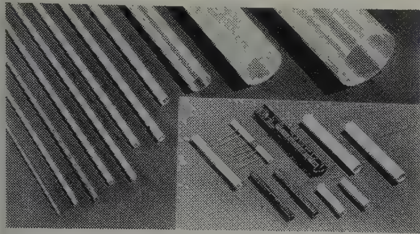
A new line of prepregs consists of various types of fabrics and fillers impregnated with polyester, epoxy, high temperature phenolic or silicone resins. Many applications of prepregs are for aircraft and missile components and electrical and electronic devices. Westinghouse Electric Corp., Micarta Div., Trafford, Pa.

Print No. Ins. 122 on Reader Service Card

'Mylar' Tubing in Wide Range of Sizes

Mylar tubes are now available with ID's from .040″ to 8″. Wall thicknesses range from .001″ to .050″ in relationship to ID. The tubes re-

portedly have a dielectric strength of 2500 vpm min. ave., continuous heat resistance of 300°F, and are rated class B (130°C). They are also said to be impervious to common solvents, alcohol, naphtha, tuluol, and similar



chemicals, as well as resistant to corrosion and fungus. Typical applications include forms for I.F., space wound, and other types of coils and flyback transformers; slot liners; capacitor jackets; magnet wire insulation; and as shafts in electrical and electronic applications where metal might produce undesirable inductive effects. Resinite Corp., Dept. IN-2, 6984 N. Central Park Ave., Chicago 45, Ill.

Print No. Ins. 123 on Reader Service Card

Randomly Oriented 'Dacron' Sheet For Lamination, Impregnation

A new type of non-woven sheet specially engineered for the electrical insulation field consists of randomly oriented "Dacron" fibers bonded into sheetings for lamination, impregnation, and other electrical uses. Tear strength of the material, known as quality 36, is said to be very high and to be nearly equal in both directions. Both sides may be produced smooth or one side may be made fuzzy to aid lamination. Thicknesses range from 2 mils to 12 mils. Morgenstern Fabrics Development Corp., 93 Hazel St., Woonsocket, R.I.

Print No. Ins. 124 on Reader Service Card

Two Epoxy Resins for Adhesives, Coating, and Impregnating

A new, low viscosity, modified epoxy resin is labeled "Araldite" DP-310. Advantages claimed are: same price as unmodified liquid epoxies, pleasant low odor, less skin sensitizing, lower vapor pressure, and higher flexural strengths. DP-310 is recommended for use in adhesives, solventless coatings, electrical encapsulating compounds, and laminating and tooling compounds where low viscosity is

required for best impregnation or maximum filler loading. Another new epoxy resin is designated "Araldite" DP-437. Recommended as a modifier for conventional liquid epoxies to produce flexible systems, DP-437 can be mixed in all proportions—giving the user a wide range of cured properties. It is said to be suitable for use in adhesives, caulking and sealing compounds, electrical potting, high-solids coatings, impregnating, and other applications. Experimental samples and further information available. CIBA Products Corp., Fair Lawn, N.J.

Print No. Ins. 125 on Reader Service Card

Pressure-Sensitive Adhesive Bonds Paper to Polyethylene

A cold setting, pressure-sensitive adhesive is suited for manual or mass production application of paper and paper labels to polyethylene in electrical and other applications. The adhesive is said to have non-staining and non-crystallizing features that assure adequate bonding under extended exposure to ultraviolet light and heat without impairment of product appearance. Application is by brush or spray followed by ordinary hand pressure. These properties make it adaptable for short run or mass production of laminated material and labels, including those used for polyethylene squeeze bottles, closures, electric and electronic cable sheaths and terminals. Labels for electrical and electronic wiring or circuit markers can be produced with release paper backing for terminals and harnesses for mass production, custom runs, short runs, or resale. Polyethylene terminal insulating sleeves can be conveniently labeled or marked to meet standard or custom requirements. Schwartz Chemical Co. Inc., 50-01 Second St., Long Island City 1, N.Y.

Print No. Ins. 126 on Reader Service Card

Custom-Made Harnesses from 'Teflon' TFE-Insulated Ribbon Cable

Savings in cost, weight, and space are some of the advantages claimed for harnesses custom-made from "Multi-Tet" ribbon cables. Insulated with Teflon, they can be used at high

temperatures and in corrosive environments. Any combination of wire sizes, conductors, and color-coding is possible. W. L. Gore & Associates Inc., 555 Paper Mill Rd., Newark, Del.

Print No. Ins. 127 on Reader Service Card

Nylon Clamps for Electrical Wiring Harnesses

A new nylon clamp for use with electrical wiring harness, named "Clamp-Tite," has been engineered to withstand vibration, pinching of wires, or bending at any point. Design features a molded wedge to prevent entrapment or pinching of wires in harness bundles and to provide a

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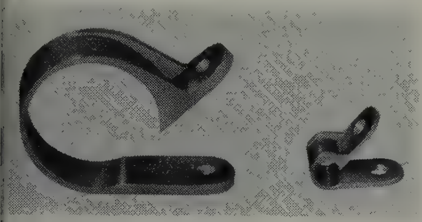
ue round diameter for retaining the arness or conduit without slippage nd vibration, and special reinforcing bs to prevent bowing or weakening f the clamps. Clamp-Tites reportedly

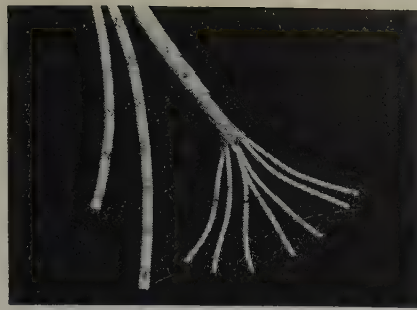


re impervious to nearly all corrosive iquids and fuels, are self-extinguishng, and will not deteriorate in salt ir. Free samples, specifications, and other information available. Olympic Plastics Co. Inc., 3471 S. LaCienega Blvd.. Los Angeles 16, Calif.

Print No. Ins. 128 on Reader Service Card

Multiconductor Cable with 'Teflon' Wires Identified by Printed Numbers

A new process for printing code numbers or letters on multiconductor cables used in electronic circuitry is said to eliminate color coding (color stripping is replaced by easy-to-read numbers). The process employs spe-

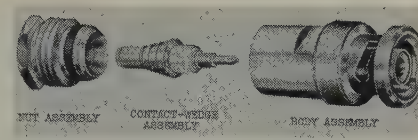


cial fluorocarbon resin inks which are sintered so that the numbers and/or letters become a permanent part of the Teflon wire insulation. American Super-Temperature Wires Inc., Winooski, Vt.

Print No. Ins. 129 on Reader Service Card

Cable Connectors

Features of captive contact wedgelock cable clamping type connectors are listed as: No combing or trimming of braid required—eliminates shorting inside the connector; assembly time is cut by more than 50%—and only three parts to handle (nut, contact-wedge, and body); no indentation of cable dielectric. Low VSWR; no special tools required for assembly; completely weatherproof—pres-



surized to 50 psi for cables with unperforated jackets; positive cable clamping—can withstand pull on cable greater than inherent strength of cables used with it; and reusable cable clamping parts. Automatic Metal Products Corp., 323 Berry St., Brooklyn 11, N.Y.

Print No. Ins. 130 on Reader Service Card

Flexible 'Teflon' Printed Circuitry

The electrical, physical, and thermal properties of Teflon FEP have been incorporated into a new circuit design concept which is claimed to offer greater design freedom, maximum reliability, lower installation costs, and package size and weight reduction. The flexible printed circuitry can be bent or twisted into any desired shape without compromising overall reliability. Terminations which are adaptable to common industry standards are offered. The Teflon insulation reportedly is not harmed by the heat needed

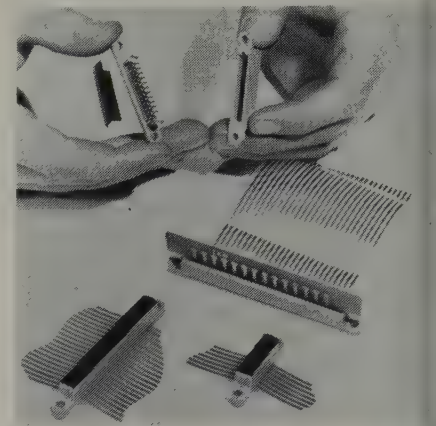
for a strong soldering bond. The etched copper circuit is encapsulated between two layers of Teflon FEP. Besides flexibility, the use of Teflon as the insulation material also offers a wide temperature range, from —122°F to +400°F. Its dielectric constant of 2.1 ±.1 remains stable throughout a frequency range of 10^2 to 10^8 cps throughout the complete temperature span. Garlock Electronic Products, Camden 1, N.J.
Print No. Ins. 131 on Reader Service Card

Improved Safety Solvent for Cleaning Electrical Equipment

An improved safety solvent, "Turco-Solv," is designed for in-place-spray-cleaning of motors, generators, switches, control panels, rheostats, and other electrical equipment. It is said to be completely non-corrosive and non-conductive; to require no hand-wiping, rinsing, or further chemical processing; to be safe to use on all metals, paint, and varnish. The product now offers a combination of detergent action plus controlled evaporation. This built-in control reportedly allows the solvent to stay wet and working just long enough to clean thoroughly in a minimum of time. It also reduces solvent vapors in the air, minimizing toxicity and flammability. Turco-Solv also is claimed to reduce consumption of material and to eliminate "touch-up" problems. Turco Products Inc., 24600 S. Main St., Wilmington, Calif.
Print No. Ins. 132 on Reader Service Card

Solderless Connections for Flat Cable and Flexible Etched Circuitry

A new device connects flat conductor cable to printed circuit boards or to flexible etched circuitry without solder. The elimination of crimped and soldered joints reportedly permits a reduction of installation time and affords a high order of reliability. A continuous one-piece spring locks the cable into the connector. In addition to its connector application, the new "Pos-E-Kon" device can be used to set up test points at any position



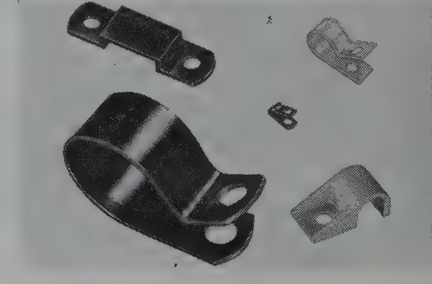
on flat conductor cable. It also can be used to connect flat conductor cables to each other without cutting conductors. The printed board connector permits the removal of both cable and printed boards at any time. Bulletin P2-39 available. The Thomas & Betts Co., Elizabeth, N.J.
Print No. Ins. 133 on Reader Service Card

Multicolored Ribbon Cable

A new line of multicolored ribbon cable is said to be manufactured to military and commercial specifications in sizes No. 28 through No. 10, up to 1″ wide and with up to 20 conductors. The plastic insulated cable for electronics, audio, automotive, marine, and aircraft uses can be furnished with conductors of all one color or of different colors. Westwood Cable Corp., 344 Overland Ave., Los Angeles 34.
Print No. Ins. 134 on Reader Service Card

Expanded Nylon Cable Clamp Line

New sizes and types of nylon cable clamps cover applications from cables smaller than 1/16″ diameter up to 1¾″ diameter. New types for special fastening applications include flat clamps, molded half-clips, and snap

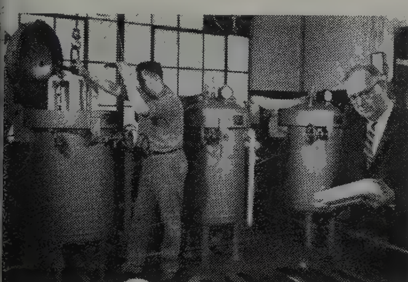


ips. The clamps, made of tough, durable, non-conducting nylon, are recommended for service between —60°F and +275°F when subjected to load. The material used is said to be one of the most solvent-resistant of all nylon types and to be unaffected by petroleum oils and greases at temperatures up to 300°F. Weckesser Co., Inc., Dept. IN-2, 5701 Northwest Hwy., Chicago 46.

Print No. Ins. 135 on Reader Service Card

Compact Coil Impregnator

New model 709 multi-impregnating unit was developed for independent coil manufacturers. Complete, platform-mounted package unit has three vacuum and pressure vessels lined with stainless steel—each with its own vacuum storage tank. The system oper-

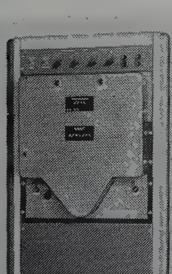


ates at 200 microns, and the three-phase system operates from a single manifold high-vacuum pump. Chief advantage cited is that it requires a minimum of floor space while providing a maximum of impregnating flexibility. J. P. Devine Manufacturing Co., 49th St. and A.V.R.R., Pittsburgh, Pa.

Print No. Ins. 136 on Reader Service Card

Automatic Capacitor Test Set

Automatic high range capacitor test set #61 offers: a capacitance range of 1 μf to 11,000 μf in four ranges at a test frequency of 120 cycles; dissipation factor range of 0 to 60% in one range; low test voltage of 0.7 v rms; accuracy of ±1% on capacitance over entire range, with accuracy of ±2% of reading +.1% on

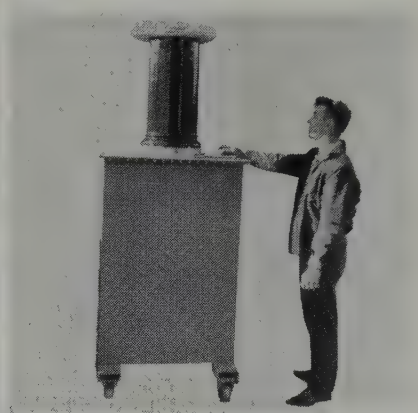


dissipation factor; and a speed of reading said to give a 4:1 advantage over manually balanced bridges. Barnes Development Co., 213 W. Baltimore Pike, Lansdowne, Pa.

Print No. Ins. 137 on Reader Service Card

150,000 Volt A-C Test Set

Meeting military and ASTM standards for dielectric testing as well as corona testing, a corona-free, castor-mounted mobile unit provides 150,000 v rms at full 15 kva capacity in a relatively small and convenient package. Other features reported include low waveform distortion below 5%, an oil-filled corona-free bushing, surge protected high-voltage transformer

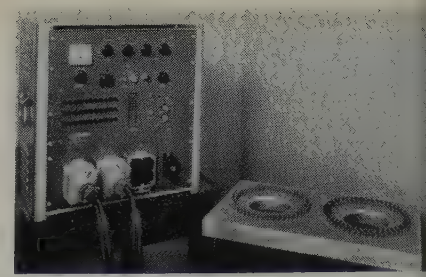


ruggedly designed for testing service, accurate output voltage metering through built-in oil immersed metering circuit at ground potential, and a built-in corona pick up network terminated in a coaxial connector for feeding an external corona detector. The unit, measuring 34″ x 34″ x 86″ high, may be purchased separately, or with a complete set of controls. Applications include corona and dielectric strength testing of HV bushings, insulators, transformers, cables, and insulating materials in general. Peschel Electronics Inc., Towners, Patterson, N.Y.

Print No. Ins. 138 on Reader Service Card

Automated Unit Sequentially Tests 450 Electrical Cable Circuits

A new 60-lb automatic tester is capable of sequentially checking up to 450 electrical cable circuits for continuity and high potential leakage resistance. The latest addition to a line of automated test equipment, the model CHA-1001 tester has adjustable rates from one circuit per minute to 10 circuits per second. Although

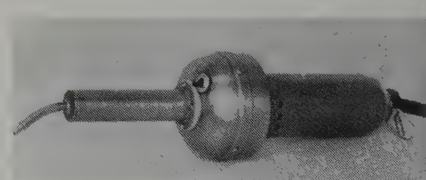


standard units are designed to test up to 150 circuits, use of "Add-A-Unit" attachments increases the test capacity in 100 circuit steps up to 450 circuits. Measuring 21¾″ wide by 22¾″ high by 12″ deep in its cabinet, the new unit is also available for rack mounting. Hipot test voltage is stated at 0 to 2100 d-c, while continuity test current is rated at 2 amps at 0.1 ohm. The tester operates from any standard 115v a-c, 60 cycle power source. Its detector power supply is Zener regulated. Operational parameters for continuity tests with the model CHA-1001 are given as 0.1 ohm to 1000 ohms minimum, and for leakage tests as 1 megohm to 200 megohms minimum. A. W. Haydon Co., Culver City, Calif.

Print No. Ins. 139 on Reader Service Card

Electro-Hot Air Welding Tools For Plastic Fabricators

A new line of electro-hot air welding tools is designed for rapid, low cost welding of vinyls, polyethylene, and other thermoplastic materials. The Model LKS is a portable, completely self contained, plastic welding unit only 15″ long. This tool consists of an



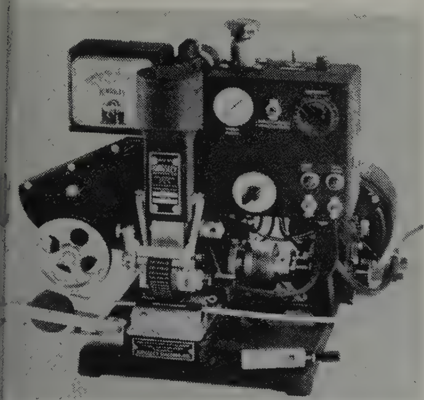
electric motor, an air turbine, heating elements, and a jet. No separate air supply is required. It plugs into any wall outlet and produces a hot air stream of considerable pressure, which is said to be absolutely free from oil, at a temperature adjustable from 350°F to over 1000°F. Price complete is $98 F.O.B. Newark, N.J. Weldotron Corp., Newark 12, N.J.

Print No. Ins. 140 on Reader Service Card

Improved Machine for Marking 'Teflon' Wire and Tubing

Featured in the air-operated KW-7

wire marking machine is a new dial-type indicating pyrometer in full vision which is furnished with an iron-constantan thermocouple attached to the heated type head. This indicates the marking temperature over a large, easy-to-read dial which is calibrated in both Fahrenheit (to 500°F) and in Centigrade (to 260°C). Using a special new marking foil, in conjunction with an electronic dwell timer and instantly adjustable air pressure unit, the improved wire marking machine

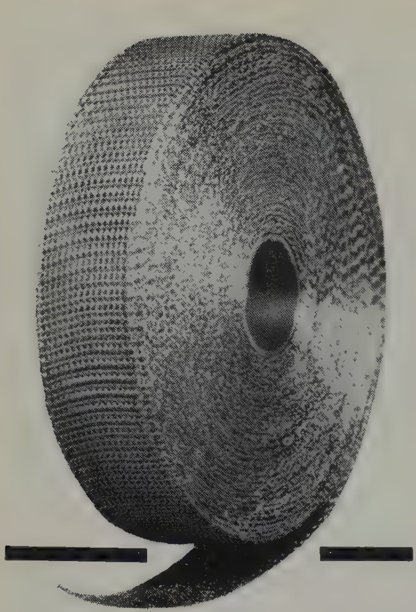


reportedly can handle Teflon as well as other plastic-coated wires and tubing at a rate of over 170 stampings per minute in continuous operation. The various improvements enable the marking of the new thin, insulated wires without dielectric damage. Kingsley Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif.

Print No. Ins. 141 on Reader Service Card

Portable Tensile Tester Combines Accuracy with Speed

Tensile tests up to 500 lb can be accurately performed on a new portable instrument called the series TJ tensile tester. The air-actuated unit is designed for bench mounting and easy operation. Its speed makes it ideal for production testing, and its accuracy, stated to be 5% of the full scale reading, makes it suitable for laboratory tensile measurements. It is designed to test a variety of small parts or material samples. In the standard series TJ tester the maximum jaw opening is 1/4″; maximum travel of moving jaw is 2″; and minimum sample length is 1″. These factors can be varied by modification or simple adjustments. Seven models of the tester have maximum capacities of 20, 50, 75, 100, 150, 200, or 500 lb, respectively. Overall dimensions are 28 1/4″ x 4 1/2″ x



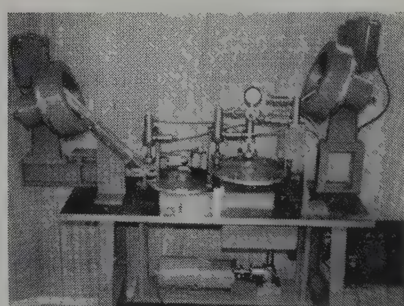
8″. It weighs approximately 35 lb. Quality Control Equipment Dept., Hunter Spring Co., A Div. of American Machine & Metals Inc., 1 Spring Ave., Lansdale, Pa.
Print No. Ins. 142 on Reader Service Card

Portable Lineman's Glove Tester

Now linemen's rubber gloves can be tested right on the job daily for hairline cracks or pinpoint leaks. The testing operation reportedly can be accomplished in less than 3 minutes. Glove is simply clamped over the top of the tester, hand inflated, and inspected. The tester comes in two sizes to fit all linemen's standard rubber gloves. E. D. Bullard Co., 2680 Bridgeway, Sausalito, Calif.
Print No. Ins. 143 on Reader Service Card

Small Parts Assembly Machine

A new assembly table can be set up for the automatic and semi-automatic production of miniature assemblies. Nine widely spaced work stations are available for a number of insertions and operations. Wide flexibility is pro-



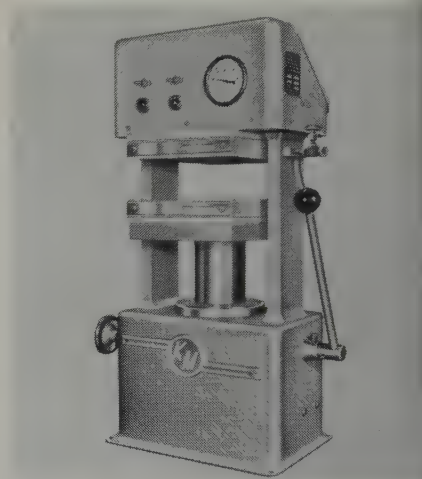
vided by the ease of changeover on the nests and parts hopper. Any combination of six hopper feeders or parts positioners may be used with the table. Aidlin Automation Inc., Dept. T-94, 1613 E. New York Ave., Brooklyn 12, N.Y.
Print No. Ins. 144 on Reader Service Card

Small Ultrasonic Cleaners

The diSONtegrator System Eighty, a 1½″ gal capacity ultrasonic cleaner, features a broad band frequency modulated circuit which eliminates the need for automatic tuning. The generator is rated at 120 watts average power and 480 watts peak power output. Fused for 5 amps, the generator operates from 117 v, 50/60 cycle line current. Price is $219.95. The diSONtegrator System Thirty, a new one pint capacity ultrasonic cleaner, is priced at $69.95. Ultrasonic Industries Inc., Ames Court, Engineers Hill, Plainview, L.I., N.Y.
Print No. Ins. 145 on Reader Service Card

Hydraulic Presses for Molding, Laminating, or Testing

Hydraulic presses that may be used for molding, laminating, or testing of plastic and rubber materials range in size from 20 to 75 tons, with platen size varying from 8″ x 8″ to 19″ x 19″. Each platen has its own individual thermoswitch which accurately controls platen temperature during electrical heating to 600°F. A metal



tube is cast in the platen for water cooling, or for steam heating. Self alignment and self leveling of the platens and maximum strength and durability with minimum weight and floor space are features cited. Descriptive brochure available. Kingsbacher Murphy Co., 9830 Bellanca Ave., Los Angeles 45, Calif.
Print No. Ins. 146 on Reader Service Card

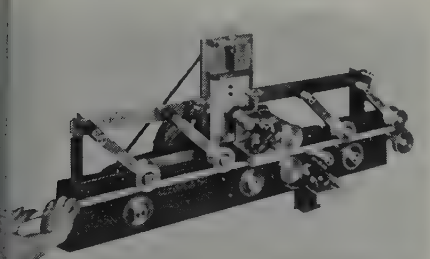
Lab Mixer for High Viscosity Fluids and Castable Polymers

A new vertical laboratory mixer, designated model 60 LP, embodies design features that make possible laboratory mixing of high-viscosity fluids and castable polymers. Two synchronized intermeshing blades and close chamber tolerances reportedly assure intimate mixing. The mixing chamber is complete with vacuum connections and is fully jacketed for mixing at controlled temperatures. The one-quart mixer is designed so that batches as small as one-tenth of a quart may be mixed in its 60-cu-in, two-cell chamber. Development Dept., Atlantic Research Corp., Shirley Ave. at Edsall

Rd., Alexandria, Va.
Print No. Ins. 147 on Reader Service Card

Tube or Rod Marker Makes Clean Imprints

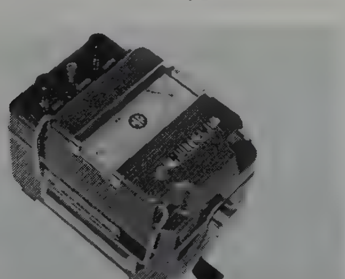
Dual flexographic inking systems on a new tube or rod marking machine reportedly provide neat and clear imprints with no smudging or blurring. The new printer marks color codes, cut-off marks, or any other identification on rigid or semi-rigid plastic, metal, or other tube or rod materials. The unit can handle 3/8″ to 3″ tubing and can be altered to suit other sizes. Average output reported is 2 to 3 tubes per minute, depending upon size and handling requirements. A bench-mounted unit, the marker is driven by a motor, ranging from 1/3-hp up to 3/4-hp, depending upon



customer requirements. Tube feeding is performed manually, but can be automated with optional equipment. Industrial Marking Equipment Co. Inc., 655 Berriman St., Brooklyn 8, N. Y.
Print No. Ins. 148 on Reader Service Card

Small Hand-Crank Insulation Resistance Tester

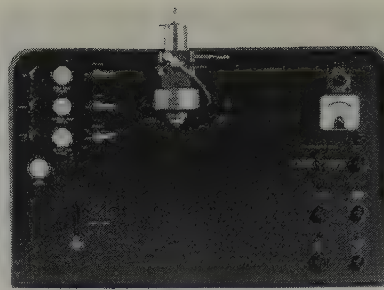
A portable hand-crank d-c insulation resistance tester is said to be simple in operation, accurate in reading, and light in weight. Known as the "Multi-Amp" type M miniature tester, it is suitable for reading insulation resistance of electrical machinery, control, communication equipment, cable, wiring, and electrical parts. Testing is by d-c which is internally converted from a-c supplied by the



manually operated generator. Testers are available for four rated voltages and five ranges of resistance as follows: 1000 v/2000 megohms; 500 v/1000 megohms; 500 v/100 megohms; 250 v/50 megohms; and 100 v/20 megohms. Accuracy claimed is within ±5% of the rated resistance values. Catalog SB-IRT-1 available. Multi-Amp Div., 465 Lehigh Ave., P. O. Box 217, Union, N. J.
Print No. Ins. 149 on Reader Service Card

Resin Dispensing Machine for Small Volume Shot

Metering, mixing, and dispensing small quantities of two-component resin systems over a wide range of materials and operating conditions is possible with the new "Micro-Shot" machine. Designed to produce a shot volume automatically from a fraction of a cubic centimeter to 20 cubic centimeters, the Micro-Shot is particularly applicable for adhesive and casting jobs. It is said to be ideally suited for end capping micro modules, transistors, resistors, capacitors, and other small volume items. An electropneumatic device, it can handle both



filled and unfilled systems, and offers temperature control features on either resin or activator systems or both. Automatic Process Controls Inc., 1170 Morris Ave., Union, N. J.
Print No. Ins. 150 on Reader Service Card

Pre-Cut Wire Dispenser Saves Time

The wiring of harnesses, control panels, and electronic assemblies is said to be speeded up by a new wire dispenser that consists of 10 high-impact plastic tubes held in a rack. Wires of any desired length can be clipped in the tube for one-at-a-time withdrawal. Racks of tubes can be mounted one upon the other with the dispenser ends of the tubes always clear. Racks can be placed on bench top with an easel stand or hung where desired. Products For Industry Inc., 1704 Summer St., Stamford, Conn.
Print No. Ins. 151 on Reader Service Card

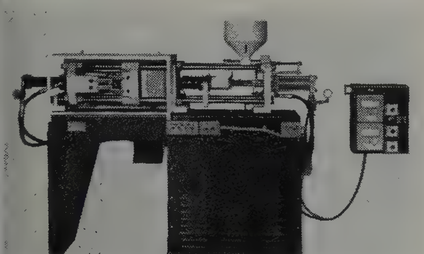
5000-V Analyzer Automatically Checks 120 Circuits for Continuity, Insulation Resistance and HV Breakdown

What is believed to be the largest high-voltage (5000 v) automatic circuit and cable analyzer ever built, the series 8520 analyzer, has automatic facilities for continuity, insulation resistance, and dielectric strength testing (a-c or d-c) of any length of cables having up to 120 conductors. Tests may be repeated or eliminated at will. The installation may be set to stop operation and sound an alarm at each failure—continuing the test

only when signalled to do so by the operator—yet retaining a record of the circuit in which failure occurred. Programs lasting from 10 minutes to 25 hours may be run unattended. Upon completion of all tests, the printed tape provides a complete record, indicating what tests were made, which conductor or group of conductors passed, as well as which ones failed. Associated Research Inc., 3777 W. Belmont Ave., Chicago.
Print No. Ins. 152 on Reader Service Card

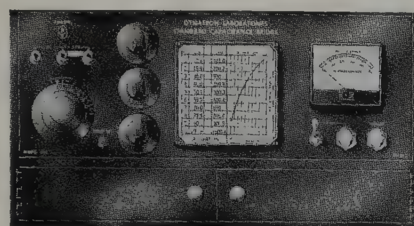
Larger Injection Molder

Increased molding capacity, up to 2 oz of styrene, is one of the many advantages featured in the newly designed, completely automatic "Imperial" Mini-jector plastic injection molding machine. Other features of model No. 80 include: standard mold size of 9⅞" x 8", maximum mold size of 11" x 8", plasticizing capacity of approximately 25 to 30 lbs/hr, dry cycle time of 5 secs without packing stroke and 7 secs with packing stroke, and a two-point toggle that provides approximately 42 tons of clamping pressure. Newbury Industries Inc., Newbury, Ohio.
Print No. Ins. 153 on reader Service Card



Capacitance Bridge

New capacitance bridge has been designed to measure capacitance ranges from fractions of a micro-microfarad to 1000 micromicrofarads.

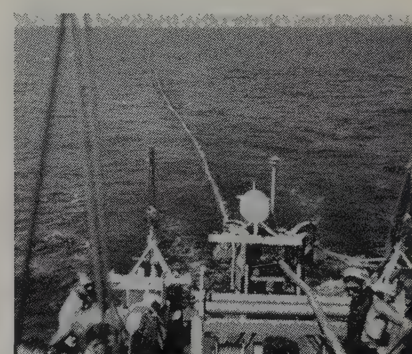


It is a completely transistorized instrument. Data sheet 101 available. Dynatron Laboratories, 71 Glenn Drive, Camarillo, Calif.
Print No. Ins. 154 on Reader Service Card

Aluminum Cables For Minesweeping

Lightweight aluminum cables have been developed for use in minesweeping. The insulated electrical cables, with external floats and electrodes attached, are towed astern of Navy minesweepers. The electric current sets up a magnetic field that explodes the mines harmlessly beneath the surface of the water.

Several different types of floated aluminum sweeper cables now being used or being tested by the Navy were developed by Kaiser Aluminum & Chemical Corp.



New Literature

All catalogs, bulletins, and other literature or sample cards described are available free of charge. To obtain your free copies, just print the item number on the Reader Service Card on the back cover. Fill out and mail the card—no postage is required. Insulation *immediately forwards your requests to the companies concerned so that the literature can be sent to you promptly.*

Glass-Polyester Selection Guide

A selection guide for glass-polyesters—water resistant glass-mat laminates and molding compounds for class B insulation applications—emphasizes features of low water-absorption, light weight, economy, flame retardance, and arc and track resistance for reliability in contaminated atmospheres. Physical and electrical properties of 10 grades of glass-mat laminates and of three grades of glass molding compounds (with low, medium, and high impact qualities) are given in brochure B8216. 8 pages. Westinghouse Electric Corp., Micarta Div., Hampton, S.C.

Print No. Ins. 201 on Reader Service Card

Polypropylene Literature And Price List

New polypropylene data include a price list, preliminary information booklet, a technical report on coloring, and a materials bulletin. Preliminary information booklet gives electrical and other properties and uses. 6 pages. Technical report TR-4 discusses coloring natural polypropylene with "Tenite" polypropylene color concentrates and includes illustrations of aids for dispersing color in injection molding machines. 5 pages. Materials bulletin MB 9 covers the properties and characteristics of Tenite polypropylene. It also suggests formulas for various types of processing. 7 pages. Eastman Chemical Products Inc., Plastics Div., Subsidiary of Eastman Kodak Co., Kingsport, Tenn.

Print No. Ins. 202 on Reader Service Card

Comprehensive Booklet on Silicones

A new and comprehensive booklet on silicones—graphically illustrated with photographs, charts, and graphs—goes into detail about what silicones are, describes their uses, and suggests ways in which they can be adapted to new applications. Of special significance is the series of charts covering the properties and features of silicone fluids, resins, rubber compounds, and anti-foams and emulsions, and their adaptability for use by the aviation, automotive, electronic, and other industries. 16 pages. Silicones Div., Union Carbide Corp., 270 Park Ave., New York 17.

Print No. Ins. 203 on Reader Service Card

Bulletin on Two Paper-Phenolic Laminates

Two copper-clad paper-phenolic laminated plastics with excellent punching and machining properties are described in technical data bulletin No. 3.1.20. Characteristics, thickness tolerances, sizes, and properties are listed. 2 pages. Taylor Fiber Co., Norristown, Pa.

Print No. Ins. 204 on Reader Service Card

Diallyl Phthalate Varnishes Bulletin

A technical bulletin on the formulation and use of insulating varnishes based on "Dapon" diallyl phthalate resins for coating, sealing, dip encapsulation, and laminating applications. Formula, application, and processing data—supported by several photographs and tables—are given in bulletin No. 32. Cured resin properties of finished coatings are also described in detail. 8 pages. Dapon Dept., Food Machinery and Chemical Corp., 161 East 42nd St., New York 17.

Print No. Ins. 205 on Reader Service Card

Epoxy Resin Bulletin

A new brochure lists properties and data for "Scotchcast" brand electrical resin No. 241. Suggestions for handling, storage, and use are included with the list of physical and electrical properties covering the two-part filled, semi-flexible epoxy resin system of

100% solids. Charts included show a comparison of pressures exerted by rigid and flexible resins during thermal cycling, viscosity characteristics of No. 241 at various oven temperatures, and curing times required at various temperatures. 4 pages. Dept. W1-58, Minnesota Mining and Manufacturing Co., St. Paul 6, Minn.

Print No. Ins. 206 on Reader Service Card

Catalog of Plastic Laminates

A new, complete-line catalog on "Textolite" industrial laminates—copper-clad, sheets, tubes and rods—has been designated L-CDL-514. It lists 39 grades and contains information on rolled and molded tubing, insulation, and printed circuit applications. Included are nine new products—two copper-clads, five standard sheets, and two new tubes. Revised data on present and improved grades are included, as well as properties, tolerances, and thickness ranges of all Textolite industrial laminates. 16 pages. General Electric Co., Laminated Products Dept., Section IS, Coshocton, Ohio.

Print No. Ins. 207 on Reader Service Card

Polyester and Epoxy Reinforced Glass Insulations Data

Literature includes descriptions, specifications, and sizes of polyester and epoxy reinforced glass rods, tubes, and shapes. Polygon Plastic Co., Div. of Plas-Steel Products Inc., Walkerton, Ind.

Print No. Ins. 208 on Reader Service Card

Epoxy Hardeners Data Sheet

A new hardener data sheet lists four new materials of interest to epoxy users. These are: 1) Hardener #41—an improved flexible polyamide adduct with lower viscosity; 2) Hardener #44—a new complex long chain amine derivative said to develop flexible resins of highest strength and adhesion plus top electricals; 3) Hardener #16 Mod.—a modified phenylenediamine eutectic for high heat and strength properties; and 4) Hardener #49—a new room temperature exotherm-free dip or adhesive hardener. Data sheet gives pot life, parts per 100 resin by wt, and remarks on outstanding properties. Disintegrators for striping cured epoxy, polyurethane, polyester, and similar compounds are also described. Isochem Resins Co., 221 Oak St., Providence 9, R. I.

Print No. Ins. 209 on Reader Service Card

Brochure on Black Glass for Insulating Diodes

Information on a special black glass for encapsulating diodes is given in a new brochure. Transmittance and other properties are detailed in a chart and a table. Information includes sizes, sealing techniques, and recommended applications. 8 pages. Receiver Bulb Sales Dept., Corning Glass Works, Corning, N. Y.

Print No. Ins. 210 on Reader Service Card

Folder on Fire-Resistant Plastic Insulations

New brochure contains a comprehensive list of all "Spauldite" fire-resistant industrial plastics which are self-extinguishing as determined by ASTM D635. It includes descriptions, characteristics, and specifications of 15 of the phenolic, epoxy, melamine, and polyester laminate type plastics. Also included is information on

copper-clad fire-resistant materials. Spaulding Fibre Co. Inc., 310 Wheeler St., Tonawanda, N. Y.
Print No. Ins. 211 on Reader Service Card

Catalog of Molded Motor Components and Insulation Parts

New catalog of molded brush retaining caps, carbon brush holders, commutators, and slip rings available from stock dies, with optional insulating materials and some engineering variations, contains engineering diagrams, descriptions, and size data. The folder also discusses automatic molding of insulating and other parts, combining of metal and plastics, and custom molding of electrical parts. 12 pages. Midwest Molding & Manufacturing Co., Gurnee, Ill.
Print No. Ins. 212 on Reader Service Card

'Teflon' Tubing Fact Sheet

New fact sheet describes spaghetti tubing which reportedly is pin hole-free and features thermal stability, extreme toughness at low temperatures, superior dielectric strength, and chemical inertness. Detailed information is given on sizes, weights, and prices. Chemplast Inc., 3 Central Ave., East Newark, N. J.
Print No. Ins. 213 on Reader Service Card

Guide to Silicones For the Space Age

Extreme heat protection; low temperature flexibility; good electrical properties; and resistance to ozone, corona, weathering, and thermal shock are some of the properties discussed in relation to silicone applications for the aerospace industry in a new reference guide to silicones. Entitled "Silicones for the Space Age," brochure CDS-276 is abundantly illustrated with photos and charts. Also included are comparative data pertaining to silicones and other compounds as high temperature insulating materials. The publication discusses silicone rubber for insulation and fabricated parts; RTV liquid silicone rubber as a potting and encapsulating compound; silicone varnishes for high temperature dipping and impregnating and thermal and dielectric coatings; clear, self-supporting silicone potting and embedding compounds for protection of electronic parts and assemblies; and silicone dielectric fluids and coolants for heat transfer and size reduction. Also covered are silicone dielectric and lubricating greases. A section of the brochure is also devoted to testing facilities available. 16 pages. Silicone Products Dept., General Electric Co., Waterford, N. Y.
Print No. Ins. 214 on Reader Service Card

Data Sheet on Flame-Retardant Laminated Plastic

A new technical data sheet gives detailed information on grade FR-2, a flame-retardant industrial thermosetting laminated plastic recommended for use as insulating parts in applications such as radio, television, home appliances, and for printed circuits in electronic computers and business machines. Grade FR-2 is a paper-base laminated plastic bonded with a plasticized phenolic resin which is non-burning. Typical property values are included. Synthane Corp., Oaks, Pa.
Print No. Ins. 215 on Reader Service Card

Bulletin on Custom Insulating Of Fine Wires

New wire sales bulletin discusses custom insulating of special conductors of various compositions and diameters as fine as .0009" for both high and low temperature applications. 1 page. Sprague Electric Co., 441 Marshall St., North Adams. Mass.
Print No. Ins. 216 on Reader Service Card

Brochure Describes New High Voltage Insulator

A line of high voltage insulators called "Struts" are described fully in "Controlled Position Construction." The brochure, No. 478-R, contains complete catalog information on these multipurpose insulators, including de-

scription, sizes, ratings, and drawings—plus photographs of the insulators showing their application. The insulators are used with standard suspension construction to control conductor position. 16 pages. Lapp Insulator Co. Inc., Insulator Div., Le Roy, N. Y.
Print No. Ins. 217 on Reader Service Card

Cable Bulletins

Two new bulletins describe in detail a variety of cables. Bulletin #10A deals with "Codastrip" flat cable constructions produced by a bonding process which groups together individually insulated and color coded conductors, twisted pairs, or coax members. The bulletin illustrates and describes typical thermoplastic insulated Codastrip cables and lists such specifications as number of conductors, AWG size and strand, insulation thickness, and nominal outside diameter. Bulletin #32 presents a similar breakdown of coaxial, microphone, shielded, and speaker cables. These include both single and dual conductors with polyvinyl chloride and with polyethylene primary insulation. Technical data for each cable variety includes approximate capacitance per foot, AWG size, approximate outside diameter, and full details regarding insulation and shielding. Phalo Plastics Corp., 530 Boston Turnpike, Shrewsbury, Mass.
Print No. Ins. 218 on Reader Service Card

Two Bulletins on Silicone Insulated Wire and Cable

Entitled "Single and Multi-Conductor Cable with Silicone Rubber," a new bulletin features power and lighting cable, hook-up wire, and ignition cable, as well as a list of conductor cables for shipboard, missiles, and nuclear power purposes. 4 pages. A second bulletin, "Wire and Cable Application Case Histories," outlines case histories of silicone rubber cable applications involving radiation-resistant cables and miniaturized switchboard wires. 4 pages. Boston Insulated Wire and Cable Co., 63 Bay St., Boston 25, Mass.

Print No. Ins. 219 on Reader Service Card

Paper on Portable Cables

A technical paper (C-118) covering the development and application of portable cables for surface mining reviews cable requirements, maintenance fundamentals, and the repair of damaged cable. Anaconda Wire and Cable Co., Dept. EFL-P, 25 Broadway, New York 4.

Print No. Ins. 220 on Reader Service Card

High Temperature Magnet Wire Bulletin

Three special types of magnet wire for use at temperatures above 250°C are described in bulletin No. 410. They include a nickel-flashed copper "Ceroc" (ceramic insulated) wire with a single or double TFE-fluorocarbon overlay intended for use from 250°C to 300°C hot spot, a 10% nickel-plated Ceroc single silicone for use from 300°C to 350°C hot spot, and a 27% nickel-clad Ceroc silicone for use from 350°C to 500°C hot spot. 1 page. Sprague Electric Co., Special Products Div., North Adams, Mass.

Print No. Ins. 221 on Reader Service Card

Catalog of Electrical Wiring Devices

New pocket-size catalog No. 101 lists, with specifications and descriptive information, wiring connectors, fuse specialties, wire and conduit straps and clamps, and wiring tools (fish tape reels and pullers, fish tape, wire strippers, cable ripper, wire gauge, etc.). 36 pages. Holub Industries Inc., Sycamore, Ill.

Print No. Ins. 222 on Reader Service Card

Connector Catalog

A new catalog lists fast assembly "ConheX" sub-miniature rf connectors for RG and other coaxial cables. Plugs, jacks, bulkhead receptacles, feed-throughs, right angle units, cable terminations, tee adaptors, printed wiring board units, adaptors, and BNC aud TNC plugs are described and illustrated with all pertinent engineering data. A chart also lists standard specification cables for use with the connectors. 12 pages. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N.Y.

Print No. Ins. 223 on Reader Service Card

Vacuum Equipment Catalog

A condensed catalog of high vacuum components and equipment summarizes a complete line of high vacuum mechanical and diffusion pumps, valves, gauges, accessories, portable pumping systems, coaters, furnaces, electron beam welders, altitude chambers, and freeze drying equipment. 8 pages. NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass.

Print No. Ins. 224 on Reader Service Card

Bulletin on Equipment for Reconditioning Insulating Liquids

Bulletin GEA-7141 discusses the features, operation, application, and filtering process of oil filter presses and "Pyranol" purifiers for reconditioning insulating liquids in transformers, regulators, and circuit breakers. Publication includes available ratings, components, and price and data tables. 4 pages. General Electric Co., Schenectady 5, N.Y.

Print No. Ins. 225 on Reader Service Card

Industrial Oven Brochure

Twin recirculation, an industrial oven principle that is said to provide uniform heat from all sides under full load conditions, to sharply reduce heat-up time, and to eliminate rejects due to faulty heat processing, is explained in new bulletin #960. A complete line of standard and specialized batch, conveyor-belt, and monorail ovens is described. Charts and photographs give physical and performance data of standard and specialized units. 4 pages. Ramco Equipment Corp., div. of Randall Mfg. Co. Inc., Electric Oven Div., 801 Edgewater Road, New York 59.

Print No. Ins. 226 on Reader Service Card

Dates to Circle

Meeting and Convention Notices

Apr. 4-5 . . . SPE, Plastics Injection Molding Workshop, Retec sponsored by Pioneer Valley Section and PAG on Injection Molding, Holy Cross College, Worcester, Mass.

Apr. 5-7 . . . AIEE, South East District Meeting, Jung Hotel, New Orleans, La.

Apr. 5-7 . . . ASTM, Symposium on Materials and Electron Device Processing, Benjamin Franklin Hotel, Philadelphia.

Apr. 5-7 . . . Institute of Environmental Sciences, Annual Convention, Hotel Sheraton-Park, Washington, D.C.

Apr. 10-11 . . . Rubber and Plastics Industries Conference, Sheraton Hotel, Akron, Ohio.

Apr. 11-13 . . . AIEE, Extra High Voltage Cable Conference, Mark Twain Hotel, Elmira, N. Y.

Apr. 17-19 . . . National Symposium on Instrumental Methods of Analysis, sponsored by ISA, Shamrock-Hilton Hotel, Houston, Texas.

Apr. 17-21 . . . American Welding Society, Annual Convention and Welding Exposition, Commodore Hotel and New York Coliseum, New York City.

Apr. 19-21 . . . AIEE, Great Lakes District Meeting, Hotel Pick-Nicolett, Minneapolis, Minn.

Apr. 19-21 . . . Annual Southwestern Institute of Radio Engineers Conference & Electronics Show, Dallas Memorial Auditorium and The Baker Hotel, Dallas, Texas.

Apr. 25-27 . . . National Conference on Electromagnetic Relays, sponsored by National Assoc. of Relay Mftrs., Student Union Bldg., Oklahoma State University, Stillwater.

Apr. 26-28 . . . SPI, 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Cal.

Apr. 26-28 . . . IRE, 7th Region Technical Conference & Trade Show, Westward Ho Hotel, Phoenix, Ariz.

Apr. 27-28 . . . The Wire Association, Regional Meeting of the Electric Wire and Cable Section, Sheraton-Atlantic Hotel, New York City.

Apr. 30-May 4 . . . Electrochemical Society, Spring Meeting, Claypool Hotel, Indianapolis, Ind.

Apr. 30-May 4 . . . Seventh National Aero-Space Instrumentation Symposium, sponsored by ISA, Adolphus Hotel, Dallas, Texas.

May 1-2 . . . AIEE, Rural Electrification Conference, Kentucky Hotel, Louisville, Ky.

May 1-3 . . . AIEE, Appliance Technical Conference, Kentucky Hotel, Louisville, Ky.

May 2-4 . . . Electronic Components Conference, AIEE, IRE, EIA, and WEMA, Jack Tar Hotel, San Francisco.

May 7-8 . . . IRE, 5th Midwest Symposium on Circuit Theory, University of Illinois, Urbana, Ill.

May 8-9 . . . SPI, Nineteenth Canadian Section Conference, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada.

May 8-10 . . . IRE, NAECON, Miami and Biltmore Hotels, Dayton, Ohio.

May 8-10 . . . Fourth National ISA Power Instrumentation Symposium, La Salle Hotel, Chicago.

May 9-11 . . . Western Joint Computer Conference, sponsored by AIEE, IRE, and Assoc. of Computer Manufacturers, Ambassador Hotel, Los Angeles.

May 17-19 . . . AIEE, North Eastern District Meeting, Statler Hotel, Hartford, Conn.

May 23 . . . AIEE, Fractional Horsepower Motors Conference, Dayton Engineers' Club, Dayton, Ohio.

May 24-26 . . . EIA, 37th Annual Convention, Chicago.

June 5-9 . . . SPI, Annual National Plastics Conference and Exposition, Commodore Hotel and the Coliseum, New York City.

June 11-14 . . EASA, Annual Convention, Jack Tar Hotel, San Francisco, Cal.

June 11-15 . . . American Society of Mechanical Engineers, Semiannual Meeting, Statler-Hilton Hotel, Los Angeles, Cal.

June 18-23 . . . AIEE, Summer General Meeting, Cornell University, Ithaca, N. Y.

June 21-July 1 . . . International Plastics Exhibition and Convention, Olympia, London, England. Address inquiries to: Interplas '61, Dorset House, Stanford St., London S.E. 1, England

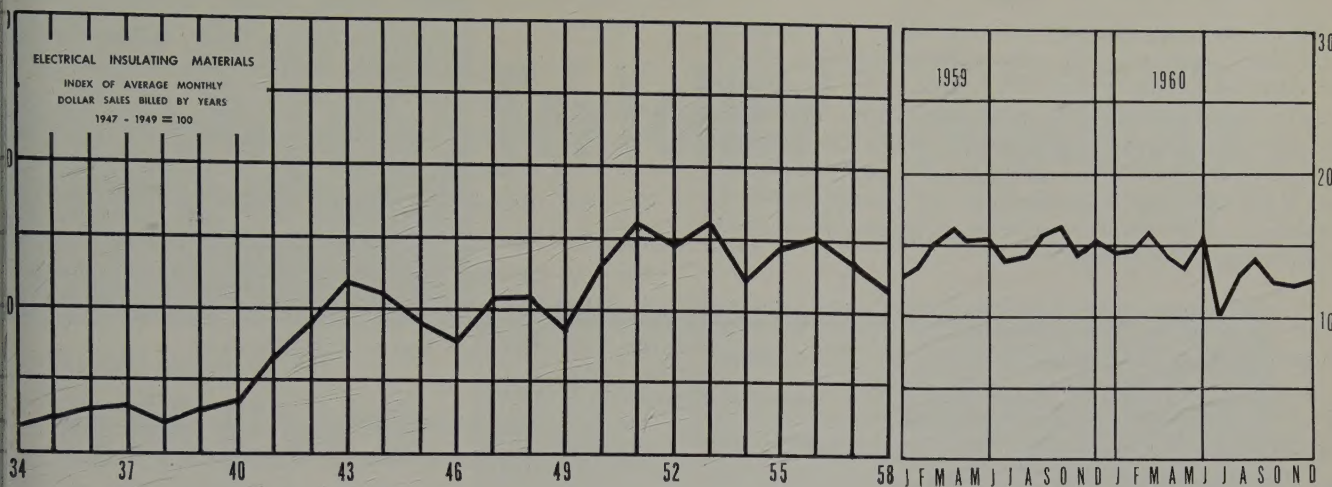
June 25-30 . . . ASTM, 64th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 26-30 . . . Western Summer Radio-Television and Appliance Market (Division of Western Home Goods Market), Western Merchandise Mart, San Francisco, Cal.

Abbreviations Used in Notices

AIEE —American Institute of Electrical Engineers
ASTM —American Society for Testing Materials
ASME —American Society of Mechanical Engineers
ASA —American Standards Assn.
IRE —Institute of Radio Engineers
EIA —Electronic Industries Assn.
NEMA —National Electrical Manufacturers Assn.
EASA —Electrical Apparatus Service Assn.
SPE —Society of Plastics Engineers
SPI —Society of the Plastics Industry
WEMA —Western Electronic Manufacturers Assn.

NEMA Electrical Insulation Index



	Dec. '60	Nov. '60	Dec. '59
ndex Series	130	123	154
)ec. '60 point change from other mos.		+7	—24
)ec. '60 % change from other months		+6	—16

ndex is based on 1947-1949 average month, inclusive= 100

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Materials Used in Electrical Insulation Index

Industrial Laminated Products
Manufactured Electrical Mica
Flexible Electrical Insulation
Vulcanized Fibre
Coated Electrical Sleeving

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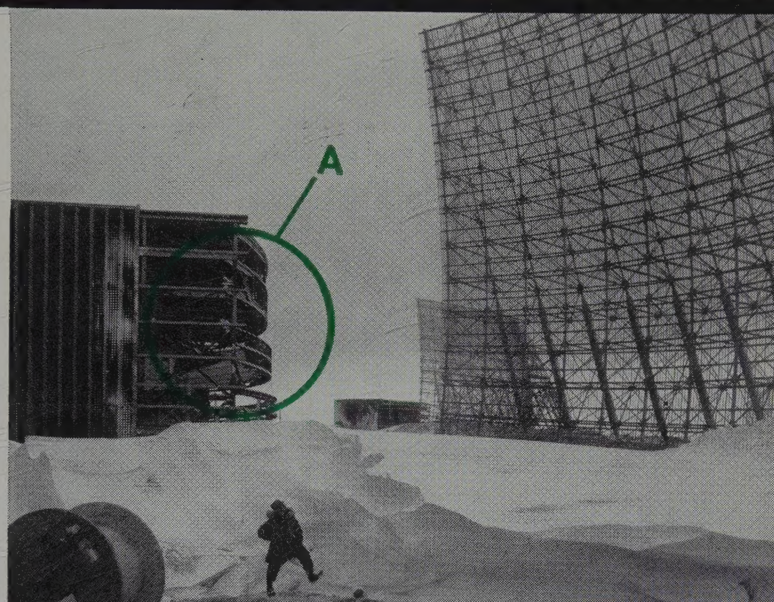

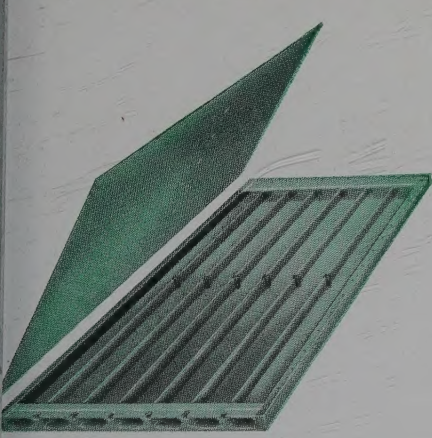

ladar Window of G-E TEXTOLITE 11546 protects xposed feedhorns (A) while permitting trans- nission of radio frequency energy. Hot air con- inually blown through window cells prevents ce formation during sub-zero arctic weather.

Towering high over the Arctic wasteland, giant radar antennas like this one (each larger than a football field) form part of the surveillance radars for the U. S. Air Force's Ballistic Missile Early Warning System (BMEWS). Developed by G-E's Heavy Military Electronics Department for RCA, BMEWS prime contractor, these surveillance radars will be instrumental in providing approximately a fifteen minute warning in case of a missile attack across the northern polar region. The first of three BMEWS sites is nearing completion near Thule, Greenland.

So gigantic is this surveillance radar that feedhorns and other vital equipments are housed in separate scanner buildings. Protecting each feedhorn from the sub-zero arctic weather is a Deicer Panel Assembly or "radar window" fabricated from G-E TEXTOLITE 11546, a G-10, high IR, glass epoxy laminate.

Micarta Fabricators Inc., an independent Chicago fabricator, built the windows for the Andrew Corporation who had the overall responsibility for the feedhorn-window system. Andrew specified TEXTOLITE after conducting a development program to select the most suitable material consistent with low cost. Tests prove TEXTOLITE 11546 meets the rigorous electrical, mechanical and environmental (—70° to +50°F, temperature variations, winds up to 185 MPH) conditions inherent in the BMEWS project.

For information on 11546 or other G-E TEXTOLITE laminates for your particular application requirements write: Laminated Products Department, Section I-41, General Electric Company, Coshocton, Ohio.

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SOME THINGS ARE JUST NATURALLY COMPATIBLE

LIKE BH ACRYLIC SLEEVINGS AND WIRE ENAMELS

Like Antony and Cleopatra, wire enamels and Bentley-Harris acrylic sleevings were made for each other. BH Acryl-A and BH Acryl-C are new acrylic-resin coated fiberglass sleevings just introduced by Bentley-Harris.

Both offer better then Class B protection at Class A cost, plus these advantages:

UNLIMITED COMPATIBILITY with wire enamels such as polyester, epoxy, formvar, etc. Under extensive testing, commercial magnet wire remains unaffected at accelerated heat-aging temperatures ranging from 180°C to 280°C. Check for yourself! Test procedure used and twisted pair specimen available on request.

EXTENDED HEAT LIFE has proven through testing, using one-h the initial rated dielectric breakdown as the end point. At 130°C, up to hours. At 155°C, up to 10,000 hours

BH Acryl-A and BH Acryl-C offe bility that rivals vinyl-glass, and at c able prices. They are craze-resista will not hydrolize.

These few facts just skim the surface advantages offered by Bentley- acrylic sleevings. Send for data she sample sleevings to get the complete Do it now!

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